Vol. 19 April, 1926 No. 4

QUARTERLY

OF THE

National Fire Protection Association

Entered as second-class matter May 1, 1911, at the Post Office at Boston, Mass., under act of July 16th, 1894.

40 CENTRAL STREET, BOSTON, MASS.

National Fire Protection Association

INTERNATIONAL.

Executive Office, 40 Central Street, Boston, Mass., U. S. A.

OFFICERS

Rudolph P. Miller, *President*
Franklin H. Wentworth, *Secretary*
Robert S. Moulton, *Assistant Secretary*

Dana Pierce, *First Vice-President*
Allen M. Schoen, *Second Vice-President*
Albert T. Bell, *Chairman Executive Committee*

Members

American Institute of Architects.
American Institute of Electrical Engineers.
American Society of Civil Engineers.
American Association of Oil Burner Manufacturers.
American Concrete Institute.
American Electric Railway Association.
American Gas Association.
American Institute of Steel Construction.
American Marine Insurance Syndicates.
American Petroleum Institute.
American Spice Trade Association.
American Water Works Association.
Arkansas Fire Prevention Bureau.
Asphalt Shingle and Roofing Association.
Associated Factory Mutual Fire Insurance Companies, Inspection Department.
Associated Lumber Mutual Fire Insurance Companies, Inspection Department.
Associated Manufacturers of Electrical Supplies.
Associated Metal Lath Manufacturers.
Association of Edison Illuminating Companies.
Association of Electragists.
Association of the Fire Alarm Industry.
Association of Fire Underwriters of Baltimore City.
Association of Marine Underwriters of United States.
Board of Fire Underwriters of Allegheny County.
Board of Fire Underwriters of the Pacific.
Board of Fire Underwriters of the Territory of Hawaii.
Boston Board of Fire Underwriters.
British Columbia Fire Underwriters' Association.
Bureau of Explosives.
Canadian Automatic Sprinkler Association.
Canadian Fire Underwriters' Association.
Canadian Manufacturers' Association.
Central Actuarial Bureau.
Central Station Fire Protection Association.
Chicago Board of Underwriters.
Clay Products Association.
Common Brick Manufacturers' Association of America.
Compressed Gas Manufacturers' Association.
Cotton Insurance Association.
Eastern Clay Products Association.
Electric Power Club.
Electrical Porcelain Manufacturers' Association.
Electrical Supply Jobbers' Association.
Factory Insurance Association.
Factory Mutual Laboratories.
Federation of Mutual Fire Insurance Companies.
Fire Equipment Manufacturers' Institute.
Fire Marshals' Association of North America.
Fire Underwriters' Electrical Bureau.
Gas Products Association.
Grain Insurance Association.
Gypsum Industries.
Hollow Building Tile Association.
Hydraulic Society.
Idaho Surveying and Rating Bureau.
Illinois Inspection Bureau.
Improved Risk Mutuals.
Indiana Inspection Bureau.
Institute of Makers of Explosives.
Institute of Radio Engineers.
Insurance Association of Providence.
International Acetylene Association.
International Association of Fire Engineers.
International Association of Fire Fighters.
International Association of Municipal Electricians.
International Brotherhood of Electrical Workers.
Iowa Insurance Service Bureau.
Kansas Inspection Bureau.
Kentucky Actuarial Bureau.
Kentucky State Dept. of Fire Prevention and Rates.
Lightning Rod Manufacturers' Association.
Louisiana Fire Prevention Bureau.
Michigan Inspection Bureau.
Millers' National Federation.
Mississippi State Rating Bureau.
Missouri Inspection Bureau.
Motion Picture Producers and Distributors of America, Inc.
Mountain States Inspection Bureau.
Mutual Fire Inspection Bureau.
Mutual Fire Insurance Association.
Mutual Fire Prevention Bureau.
National Association of Building Owners and Managers.
National Association of Credit Men.
National Association of Dyers and Cleaners.
National Association of Insurance Agents.
National Association of Manufacturers of Approved Hollow Metal Window Frames and Sash.
National Association of Manufacturers of United States.
National Association of Sheet Metal Contractors of United States.
National Association of Steel Furniture Manufacturers.
National Automatic Sprinkler Association.
National Board of Fire Underwriters.
National Convention of Insurance Commissioners.
National Electric Light Association.
National Lumber Manufacturers' Association.
National Petroleum Association.
National Slate Association.
National Varnish Manufacturers' Association.
National Wholesale Druggists' Association.
Nebraska Inspection Bureau.
New Brunswick Board of Fire Underwriters.
New England Bureau of United Inspection.
New England Insurance Exchange.
New Hampshire Board of Underwriters.
New Jersey Schedule Rating Office.
New York Board of Fire Underwriters.
New York Fire Insurance Rating Organization.
Newfoundland Board of Fire Underwriters.
Nova Scotia Board of Fire Underwriters.
Ohio Inspection Bureau.
Oil Insurance Association.
Oklahoma Inspection Bureau.
Oregon Insurance Rating Bureau.
Pacific Coast Association of Fire Chiefs.
Philadelphia Fire Underwriters' Association.
Philadelphia Suburban Underwriters' Association.
Portland Cement Association.
Pyroxylin Plastics Manufacturers' Association.
Railroad Insurance Association.
Sheet Steel Trade Extension Committee.
South-Eastern Underwriters' Association.
St. Louis Fire Prevention Bureau.
Suburban Fire Insurance Exchange.
Tennessee Inspection Bureau.
Terminal Elevator Grain Merchants' Association.
Texas Inspection Bureau.
Texas State Fire Insurance Commission.
Underwriters' Association of the District of Columbia.
Underwriters' Association of the Middle Department.
Underwriters' Bureau of Middle and Southern States.
Underwriters' Bureau of New England.
Underwriters' Laboratories.
Underwriters' Service Association.
Union, The.
United States Fireworks Manufactures' Association.
Washington Surveying and Rating Bureau.
Western Actuarial Bureau (Fire).
Western Canada Fire Underwriters' Association.
Western Factory Insurance Association.
Western Insurance Bureau.
Western Sprinklered Risk Association.
West Virginia Fire Underwriters' Association.
West Virginia Inspection Bureau.
Wisconsin Inspection Bureau.

Over 4100 Associate Members

Table of Contents.

GALVESTON WHARF FIRE.....FRONTISPIECE

EDITORIALS 309

PLANNING A LOCAL CAMPAIGN FOR FIRE PREVENTION. *Cartoon*.... 314

MEETING OF EXECUTIVE COMMITTEE..... 315

PICTORIAL COMMENT. *Cartoons*..... 320

A HOME DRY CLEANING TRAGEDY..... 322

STOPPING FIRES DUE TO CHIMNEYS AND FLUES. *D. Knickerbacker Boyd* 323

A FILM BOOTH FIRE..... 328

THE POKER AS PRIEST. *G. K. Chesterton*..... 329

STEAM PROTECTION FOR OIL TANKS. *G. O. Wilson, Standard Oil Company of California*..... 330

PRIVATE FIRE SERVICE CHARGES IN CHICAGO..... 344

ANOTHER PERSONAL LIABILITY DECISION..... 347

CITIES' LEGAL POWER TO PREVENT FIRES..... 349

SILK AND RAYON. *Wm. D. Grier*..... 352

Department of Fire Record.

LAFAYETTE HOTEL FIRE, ALLENTOWN, PA. *E. S. Chapin*..... 364

OUTSIDE SPRINKLERS SAVE FACTORY BUILDING..... 367

THE CHATEAU FRONTENAC FIRE..... 369

THE SECOND EQUITABLE BUILDING FIRE. *William B. White*..... 373

GALVESTON WHARF FIRE—MALLORY LINE PIERS. *H. Oram Smith* 383

A PYROXYLIN LACQUER SPRAY FIRE. *Western Factory Insurance Association* 388

FIRES IN WHICH THERE WAS LOSS OF LIFE..... 393

ANNUAL SUMMARY OF FIRES IN SPRINKLERED PROPERTIES..... 396

INDEX TO VOLUME 19..... 406

Reports of fires appearing in the Quarterly are copies of or extracts from written reports forwarded to the Association. This Association, as a body, is not responsible for the statements or opinions of any of its members.

The Galveston Wharf Fire. Airplane view of burned piers on morning after the fire showing west wall still standing; the concentration of streams on this wall formed a heat barrier protecting Pier 27 beyond. Roadway crossing at 29th Street beyond grain elevator marks the only approach from the west end. (See report on page 383.)

The Quarterly

Vol. 19 April, 1926 No. 4

The Thirtieth Annual Meeting. The thirtieth annual meeting of the Association, scheduled for May 10, 11, 12, 13 in Atlantic City, will be held in the Vernon Room of Haddon Hall as in 1924. There is nowhere a better place to work than Atlantic City, and this year's budget of important matters is certain to be handled by the membership with its usual diligence and thoroughness. It is believed that the new plan of opening the meeting on Monday afternoon will afford sufficient time for disposing of the program without the feeling of stress that in late years has been imposed upon us. The other innovation is the scheduling of all committee reports at definite hours. The Program Committee will do its best to estimate with reasonable accuracy the probable amount of time required for disposing of each report. Where the discussion on any report is unduly prolonged a place will have to be found for its continuance later in the sessions. The official program, to be mailed to members shortly, and the announcements in the *News Letter*, will indicate the budget of committee reports to be presented and other items of the meeting.

* * * * *

"Fireproof" Office Building Fires. The experience of many fires has already proved beyond question that there is no such thing as a "fireproof building." The fire in the Equitable Building, New York, described in detail in this QUARTERLY, furnishes an interesting and somewhat spectacular confirmation of this well established fact. This fire received much newspaper publicity and probably has done much in educating the New York public as to the possibilities of fire in the best "fireproof" buildings.

Another somewhat similar office building fire is reported from New York in the Park Row Building, occurring on February 27, shortly after the Equitable Building Fire. Because of space limitations no detailed report on this fire is published in this QUARTERLY. A fire, involving a loss to the building of about $15,000 and to the contents of some $9,000,

occurred in a structure which was generally regarded as "fireproof." In this case there was no such unusual combination of circumstances as was responsible for the Equitable Building fire. It was simply an office fire, supposedly caused by a lighted match in a wastebasket. Due to the location of the fire in a wing of the building and to prompt and effective work by the fire department the damage was practically confined to a group of offices on the fifth floor with a single room on the sixth floor also damaged.

The loss in the contents of these offices was practically total. Records in steel filing cabinets were completely destroyed or so damaged as to be practically worthless. This fire must have been a very serious blow to a number of the smaller tenants occupying offices in this section. These people, like the great majority of the occupants of "fireproof" office buildings, felt secure in their supposed immunity from fire, due to the character of the building. Their belief in this seems to have been complete as is evidenced by the fact that in almost no case was insurance carried on the contents of these offices.

* * * * *

The Fire Chiefs' Big Plan.

The International Association of Fire Engineers, organized as a fire chiefs' body in the days when the operation of the steam fire engine suggested their title, has long served as a vehicle to bring the chiefs together annually for social purposes and exchanges of personal opinions and experiences. Composed largely of the same members, but confined in their activities to certain sections, the Dominion Association of Fire Chiefs, the Pacific Coast Association of Fire Chiefs and the New England Association of Fire Chiefs have been able to function more effectively as educational bodies, their conventions being conducted as business meetings with the minimum of entertainment.

Now, out of the Pacific Coast Association, comes Jay W. Stevens, whose fine enthusiasm and tireless energy has left its mark not only on the organization of which he is the executive but upon the entire fire prevention movement of the Pacific Coast. Mr. Stevens aims at nothing less than the elevation of the "International" to the plane of usefulness occupied by the regional bodies through the gathering of funds, the establishment of an executive office, the creation of a literature, and the evolution of such other functions as shall make the fire chiefs' body what he believes it should be, the effective and natural sponsor of fire protection in the nation. Mr. Stevens in several emergencies on the Pacific Coast has demonstrated that he has no equal in straightening out complications in fire departments and there is certainly a fertile field for his talents in this direction the country over. Besides being state fire marshal of

California he is chief of fire prevention of the National Board of Fire Underwriters with office in San Francisco.

Mr. Stevens' plan for raising funds for his big idea is already under way and has been enthusiastically endorsed by the fire chiefs' body. It consists of the production of a motion picture by one of the "movie" companies, to be shown commercially throughout the nation, the attendance in every city to be stimulated by the local fire chief, a portion of the earnings of the picture to be given by the producing company to the fire chiefs' body to finance the activities Mr. Stevens has designed for it. Mr. Stevens has long been a devoted member of the N.F.P.A. and his success in raising the fire prevention morale of the fire fighting forces of the Pacific Coast cities has been so obvious as to modify the need for N.F.P.A. field service west of the Rocky Mountains while the cities of the East and Middle West exhibit so glaring a need for special attention. Mr. Stevens' motion picture is almost ready for production and he has considerably stimulated the interest of the fire chiefs in it by conducting a contest among them for an appropriate and effective title. It will probably be ready for the picture houses in the fall.

* * * * *

A Small City's Achievement. Albany, Georgia, has won not only first prize among the cities of its class, but the grand prize among cities of all classes entering the fire waste contest for 1925 conducted by the National Chamber of Commerce. Albany won first prize for 1924 in its own class, repeats its triumph for 1925, and for its intelligent and effective fire prevention activities now leads the entire country. A low fire loss and a small number of fires in proportion to population for a single year may well be an accident. But when a city shows a consistent record of a small number of fires and a low fire loss over a period of years there is more than negative evidence that something besides good fortune must be given credit for results.

Albany has a population of 18,000. Its fire waste in 1924 was $7,838, or $0.43 per capita. Its average per capita loss for the five year period 1920-1924 was $1.73. For 1925 it was $1.50. There has been no life loss from fire in Albany for 15 years. Notwithstanding the rapid growth of this little city and the greater property risk involved the fire alarms have been reduced from 135 in 1916 to 127 in 1925, while nearly every other city in the country shows marked fire alarm increases for this period. Albany is favored with the lowest fire insurance rate of any city in Georgia, perhaps in the South.

What is the explanation of the forces and conditions present in this little Southern city that enable her to surpass all other cities large and small in fire safety? Albany has a fire chief of such character and intel-

ligence as actually to be able to register his efforts. His personal influence extends into the humblest home in Albany. All of the fire prevention educational activities found useful in other cities have for several years been carried on by him, but something else has been going on. The fire chief has brought local improvements definitely to pass. He has taken his logical position as the conservator of Albany's fire safety, and his public educational routine has been established with the object of building up a community interest and morale that would permit him to do definite things. This public intelligence began to register some years back. The chief began to investigate the cause of every fire, and publish it. Most fire causes constitute personal criticisms if made public. People do not like to be held up for inspection. Three years ago a reasonable building code was enacted. This is being enforced. The code outlawed the wooden shingle. Forty-five of the 127 fires last year were from this cause,—sparks on old wooden shingle roofs not yet replaced. Albany will soon be reasonably free from this pest and menace.

Then there is the unusually competent administration of the fire department itself. The uniformed firemen inspect the city continuously. This does not mean strolling down the street and marking something on a pad. The department sends a uniformed fireman through every cotton warehouse in the city at 10 P. M., 1 A. M. and 4 A. M. every night. During the drouth last year the ginning plants were continuously supervised and the firemen located and removed seven individual bales of cotton, at different times, that were on fire, the loss in each case being confined to a small portion of the bale. Through the night, regular rounds of the business district are made with inspections of each store and building. Several small fires were thus discovered last year and extinguished with slight loss in premises where the potential loss was great. The department carries salvage covers on the apparatus and its efficiency has so increased as the men have progressed in this necessary work, during and after fires, that many hundred dollars of property damage was avoided last year. The officers and members are thoroughly trained and kept physically fit by regular daily exercise and weekly company drill with the equipment.

As a result of the general fire prevention consciousness of Albany the provision of an additional reservoir for water storage was secured with little opposition and its wisdom demonstrated at the only serious fire of 1925. One hundred and twenty-six of the 1925 fires were controlled with a loss of $6,106. The one hundred and twenty-seventh was the Southeastern Compress fire, occurring in the drouth period. The building was 200 feet by 1,200 feet, entirely frame, but with two fire walls. This fire had gained great headway before the department arrived but was confined to one of the compartments with a loss of $21,000 and salvage of $483,000.

The department used 16 hose streams on this fire with a hydrant pressure of 125 pounds and despite the dry period did not deplete the water storage supply. Had it not been for this fire the per capita loss of Albany for 1925 would have been but 33 cents, comparing favorably with Continental Europe.

When we contemplate the conditions that exist in Albany, the consciousness of her people and the competence and intelligence of her fire department, while knowing the conditions that exist in the average American city, we are led to wonder how many years in succession she will walk off with the prize given for fire prevention superiority. In January of this year, before the second and grand prize had been won, a larger city made a bid for Albany's fire chief. He declined the offer. He enjoyed working in a city whose citizens gave him co-operation and shared his pride in advancing fire safety. Not being backward in showing appreciation of his fine attitude the city increased the chief's compensation fifty per cent. We shall be surprised if Albany, Georgia, is soon overtaken in her race with the still comparatively small number of cities who are manifesting interest in their fire safety.

* * * * *

The Annual Sprinkler Tables. The thirtieth annual sprinkler summary, published in this QUARTERLY, is a noteworthy example of the continuing character of the Association's activities. The automatic sprinkler, generally accepted as the most effective form of fire protection yet devised, is shown by these tables to have an efficiency of 95.8%, a most remarkable record for a mechanical device such as this. The true efficiency of the sprinkler as a device may be said to be somewhat higher than this, for in the tables a sprinkler failure is recorded every time that a system fails to function, whether the failure is due to some shortcoming of the equipment or whether it occurs because the water was shut off, in which case it seems hardly fair to blame the sprinkler system. The efficiency recorded in the tables is a combined figure showing the net results including both mechanical efficiency and the human factor. If a figure showing the mechanical efficiency were segregated it would be considerably higher than the percentage shown in the tables. The fact that in only four per cent of the fires recorded was there failure, either mechanical or due to the human factor, may also be considered as testimony to the high caliber of the maintenance which sprinkler systems in general receive.

Comparing the current summary with the results of previous years it is found that the present average efficiency of sprinklers is not materially different from what it was ten or twenty years ago. The efficiency for the year just ended is less than one per cent higher than the average results over the thirty year period. There has been progressive improvement in

sprinkler devices and in installation methods that is apparently not fully reflected in the sprinkler tables. This may be due to the fact that the average present day system has more extensive hazards to protect than that of twenty years ago, or perhaps may be explained by the fact that the majority of sprinkler failures are due to the human element and that the number due to inherent faults of the system is so small that variations in this factor due to improvements in equipment do not register any very noticeable change in the overall efficiency figures.

Planning a Local Campaign for Fire Prevention.

—Reproduced from American City Magazine.

Meeting of Executive Committee.

January 30, 1926.

The midwinter meeting of the Executives was held at Atlantic City on January 30, 1926. The following members were present:—

Albert T. Bell, Atlantic City, Chairman
George W. Booth, New York
Edward R. Hardy, New York
S. D. McComb, New York
H. L. Miner, Wilmington, Delaware
F. T. Moses, Providence
W. W. Orr, New York
W. F. Steffens, New York
P. W. Terry, St. Louis
Louis Wiederhold, Jr., Philadelphia
Rudolph P. Miller, New York, President
H. O. Lacount, Boston, Past-President
Dana Pierce, Chicago, Vice-President
A. M. Schoen, Atlanta, Vice-President
Franklin H. Wentworth, Boston, Secretary-Treasurer.

There were also present by invitation: A. R. Small, Chairman Electrical Committee; R. S. Moulton, Assistant Secretary; Percy Bugbee, Field Engineer; W. J. Canada, Electrical Field Engineer, and Miss Eve VeVerka, Financial Secretary.

The program of the annual meeting, May 10-13, was discussed and plans proposed by the Marine Committee were approved and referred to the Program Committee.

The possibilities and needs of our Field Service were discussed and the efforts and methods initiated by the Finance Committee for raising funds for the maintenance of the same unanimously approved. The New York members of the Executive Committee were constituted a special committee to consider ways and means of raising funds in the City of New York and to contribute suggestions thereon to the next meeting of the Executive Committee. The members of this special New York Committee are: Edward R. Hardy, Chairman, W. E. Mallalieu, Rudolph P. Miller, W. W. Orr, George W. Booth, S. D. McComb and W. F. Steffens.

The desirability of an energetic and continuous campaign for new members was discussed and the Finance Committee was authorized to establish a membership department at a cost not to exceed $6,000 for the first year.

A representative of the Electrical Manufacturers' Council appeared before the Committee with the suggestion that the Council be given representation on all N.F.P.A. technical committees dealing with electrical matters, and that the regulations of the N.F.P.A. be submitted to the

American Engineering Standards Committee for acceptance as American Standards. The Secretary was requested to outline by letter to the appellant present N.F.P.A. practices and policies respecting these matters which are believed to be in accord with the spirit of his suggestions.

It was expressed as the sense of the Executive Committee that our present representative on the Executive Committee of the American Engineering Standards Committee should be guided by his own judgment as to matters to be referred to the N.F.P.A. Executive Committee before voting.

The matter of submission of certain additional N.F.P.A. regulations to the American Engineering Standards Committee for adoption as American Standards was discussed without formal action.

The invitation of the A.E.S.C. to the Fire Group to accept joint sponsorship with the American Society for Testing Materials for a sectional committee on fire hose was accepted on behalf of the N.F.P.A. and the Executive Office was authorized to proceed with the formation of the sectional committee, in co-operation with the other participating organizations.

The Executive Office was authorized to submit to the American Engineering Standards Committee for acceptance as American Standard the N.F.P.A. regulations for threads for small fire hose couplings.

On recommendation of the Committee on Gases the following amendments to regulations governing Gas Systems for Welding and Cutting were adopted; being matters referred by the annual meeting to the committee for further consideration and report to Executive Committee.

Rule 11, add "Note: An open connection for the sludge draw-off at the generator is desirable to enable operator to observe leakage of generating water from the sludge cock."

Rule 28 (c), omit last sentence reading "Such generator room or compartment may also be used for the storage of fuel gas cylinders."

Rule 28 (d), omit last clause of first paragraph reading "or in outside generator house", and add the following sentence: "Calcium carbide in excess of 5,000 pounds may be stored in outside generator houses."

Rule 34 (a), add at end of paragraph "unless approved for the purpose." (Refer to Proceedings 1925, pp. 94 to 101 inclusive.)

The Secretary was instructed to reply to a communication received from the Bureau of Standards requesting an opinion on the merits of a plan for promoting the use of specifications by the purchasers of devices and materials, that the committee could not speak for the members of the Association in this matter.

Respecting a communication submitted by the Chairman of the Electrical Committee containing suggestions from an Electrical Committee member for amendment to rules for committee procedure, the Secretary was instructed to advise the Chairman of the Electrical Committee that the Executive Committee could not consider relinquishing its right to appointment of the chairmen of committees.

A memorandum from the Secretary of the Committee on Flammable Liquids, respecting the forms in which regulations governing oil storage should be presented to the Association, was referred to the Secretary.

It was expressed as the sense of the Executive Committee that in general it is the province of technical committees to provide standards of installation, maintenance and results to be obtained, rather than specifications for materials, design and tests.

The Secretary was authorized to appoint a representative of the Association upon the Committee on Life Loss Statistics of the Fire Waste Council of the Chamber of Commerce, U. S. A.

It was *voted* to instruct committees to use the word "approved" in their reports as referring to approval by the authority having jurisdiction in the enforcement of the regulations.

The recommendation of the Field Practice Committee to revise rule 61 of the Regulations on Outside Protection to read as follows was approved:

> Pipe and fittings suitable for the working pressures shall be used. They shall conform to the specifications of the American Water Works Association Class "C" for pressures less than 150 lbs. per sq. in. and correspondingly heavier for higher pressures, or be tested and listed by Underwriters' Laboratories.

Note: The weights for Class "C" pipe under the specifications of the American Water Works Association are:

(No change in table.)

The Executive Office was authorized:—

(a) To recreate the Committee on Electric Railway Car Houses and Cars in order to provide the machinery for further co-operation with the American Electric Railway Association (Member N.F.P.A.).

(b) To create a new committee on Farm Fire Protection with D. J. Price (Department of Agriculture U. S.) as Chairman.

(c) To make the following additions to or corrections in rosters of existing committees:—

1. *Automatic Sprinklers:*
   Add C. W. Mowry, Boston (Representing Factory Mutual Laboratories).
2. *Electric Power Houses:*
   Add (a) J. Sanderson Trump, Philadelphia (Representing Philadelphia Fire Underwriters' Association).
   (b) W. W. Johnston, Pittsburgh (Representing Board of Fire Underwriters of Allegheny County).
   (c) K. F. Akers, New England Insurance Exchange, Boston (Replacing M. F. Cherry).
   (d) Representing Electric Power Club:
   1. R. W. E. Moore, Westinghouse Electric Co.
   2. A. H. Moore, General Electric Company.

(e) Representing National Electric Light Association:
1. Granville H. Bourne, New York City.
2. Alexander Maxwell, New York City.
3. (Additional representative.)

(f) Representing American Electric Railway Association:
1. G. C. Hecker, New York City.
2. L. D. Bale, Cleveland Railway Company, Cleveland, O.

(g) Representing American Institute of Electrical Engineers:
1. Farley Osgood.

(h) W. J. Canada (Non voting).

3. *Committee on Building Construction:*

Add (a) Lee H. Miller, Cleveland (Representing American Institute of Steel Construction).

(b) Fitzhugh Taylor, Chicago (Representing Underwriters' Laboratories).

(c) Frank P. Cartwright, Washington (Representing National Lumber Manufacturers' Association).

4. *Electrical Committee:*

Add (a) W. W. Vaughn (Representing the New York Fire Insurance Rating Organization, Syracuse Division, in place of Geo. E. Bruen of the Suburban Fire Insurance Exchange, resigned).

(b) R. L. Weber of Stone & Webster, Boston, representative of the American Electric Railway Association, succeeding Mr. Martin Schreiber.

5. *Field Practice:*

Add (a) Charles R. D'Olive, Fyr-Fyter Company, Dayton, Ohio, representing the Fire Equipment Manufacturers' Institute, succeeding Mr. A. O. Boniface.

6. *Fire Record:*

Add (a) Mr. Frank J. McFadden, New York City.

7. *Marine:*

Add (a) Captain W. C. Foley, U. S. Salvage Association, New York, representing the American Marine Insurance Syndicates, succeeding Mr. J. A. Wilson.

8. *Private Supplies from Public Mains:*

Add (a) R. W. Hendricks, Underwriters' Laboratories, Chicago.

9. *Protection Against Lightning:*

Add (a) W. J. Alcock, Chicago, representative of Underwriters' Laboratories in place of Mr. B. H. Glover.

10. *Safety to Life:*

Add (a) Mr. S. V. James, representative of Underwriters' Laboratories.

11. *Signaling Systems:*

Add (a) W. J. Smith, New York, representing the Association of the Fire Alarm Industry, succeeding B. B. Hatch.

12. *Tanks:*

Add (a) C. D. Abbott, Boston, as Chairman of the Committee, replacing R. E. Manning, both of the Associated Factory Mutual Fire Insurance Companies. (H. A. Sweet of the same organization retires.)

(b) A. W. Claussen, Chicago, representing Underwriters' Laboratories.

(d) To make or confirm the following additions to or corrections in N.F.P.A. representation upon Committees of the American Engineering Standards Committee:—

1. A. R. Small, to Safety Code Correlating Committee (succeeding Dana Pierce).
2. Fire Group appointments, Main Committee:
   (a) C. W. Mowry.
   (b) A. R. Small (to serve the balance of Mr. Pierce's term).
3. Executive Committee—A. R. Small.
4. Committee on Code for Identification of Piping Systems—Ira Hoagland (succeeding J. C. Forsyth, resigned).
5. Methods of Testing Petroleum Products and Lubricants:
   (a) A. H. Nuckolls, Chicago.
   (b) George W. Angell, Boston.

(e) To confirm the appointment of E. E. Turkington as N.F.P.A. representative, National Safety Council Engineering Section, Electrical Committee.

Spectacular, But They Come High

Knott in the Dallas *News*.

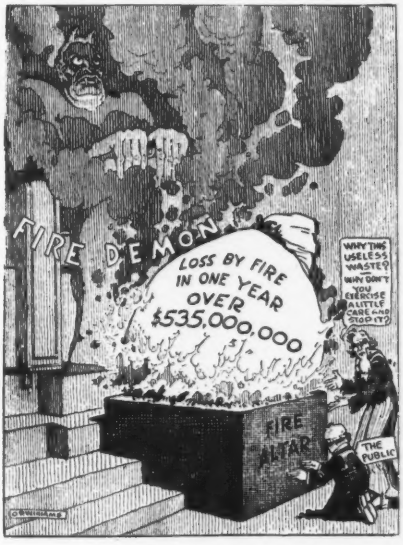
HIS BAG OF TRICKS

Baltimore *American*.

RIGHT-OF-WAY NEEDED!

Keith Temple
in the New Orleans
Times-Picayune.

A COSTLY BURNT OFFERING


FIRE DEMON
LOSS BY FIRE IN ONE YEAR OVER $535,000,000
WHY THIS USELESS WASTE?
WHY DON'T YOU EXERCISE A LITTLE CARE AND STOP IT?
FIRE ALTAR
THE PUBLIC

O. P. Williams
in the
Detroit *Times.*

Courtesy Fireman's Fund Record.

A Home Dry Cleaning Tragedy.

This picture shows the sink at the right where Mrs. D. G. Gallic was washing curtains in gasoline in the kitchen of her San Francisco apartment last December. No doors or windows were open. At the left is a gas water heater, with a pilot flame continuously burning. She was burned to death. The *Fireman's Fund Record* quotes the brother of the dead woman as follows:

"They were busy getting the place all fixed up for Christmas. My brother-in-law was washing the front windows. You see, some of the Bon Ami is still on them. All the curtains are down. My sister had them out here in the sink washing them in gasoline. There's the glass jug they used to get the gasoline from the service station on the corner.

"These spots on the rug are from the chemicals the boys from the service station used. I'll tell you they deserve a lot of credit. The minute they heard the explosion they came running right up here with extinguishers. One of them said he guessed what had happened. He remembered filling the jug with gasoline a few hours before.

"See how that rug is pulled crooked. He tried to jerk it out to wrap around her but the dining room table was too heavy. He knocked her down then and rolled her across the floor—but it was too late. Her hands and arms were covered with gasoline and her clothes were saturated with the fumes. These scorched places on the table are where her hands and clothing touched. She was a human torch as she ran out of that blazing kitchen."

Stopping Fires Due to Chimneys and Flues.

By D. Knickerbacker Boyd (Member N.F.P.A.).
Architect and Structural Standardist.

The fact that the second largest cause of preventable fires is "defective chimneys and flues," is of especial importance to the building industry. A fire which is due to any detail of construction whatever should be given particular attention by all those affiliated with that industry collectively and individually.

That defective chimneys and flues are classed as preventable causes of fire indicates, as is quite true, that chimneys and flues should not be defective and can be properly built. When in the future all new chimneys are properly built, there will still remain those which are now defective and which though sometimes difficult to locate and remedy must nevertheless be watched for and rebuilt or otherwise corrected.

Causes of Chimney Fires.

Roughly speaking there are three principal ways by which chimney fires are caused. The first is due to faulty or inadequate construction which allows sparks or heated gases to pass through cracks or openings in the chimney walls and reach combustible material. The second is due to providing for the connection of more than one heating apparatus to a flue which makes it possible for sparks and hot gases to find a ready outlet within the structure when only one connection is in use. Soot collects in the unused connection and when, in very cold weather, the chimney is heated beyond normal working conditions, a fire ensues; or if several pieces of apparatus are using one flue it becomes over heated and may radiate sufficient heat to start combustion. The third is due to the flue being too small for its intended use; it is a fact, because of lack of knowledge heretofore obtaining and the false idea of economy current with many builders, that vast numbers of flues have been made too small.

The second condition accounts in part for the numerous fires which always accompany a severe cold spell, and the third has been much in evidence recently when flues intended for burning anthracite have been used with various other fuels. Defects in a chimney which are not noticed in ordinary operation become a cause of disaster when abnormal conditions are encountered.

Simplicity of Construction.

A chimney is not a very complicated structure and can and should be built properly. The temperature of the gases of combustion is not excessive except for high pressure boilers where a specially designed

chimney is usually built under competent supervision. These are a special class and are not included in this general discussion.

A chimney is usually built of brick or stone and consequently there are many mortar joints which might not be absolutely tight. Therefore any method by which the number of joints can be reduced or protected is of the greatest value. Formerly this was done by "parging" or plastering the inside of the flue, but as the plaster eventually falls off and is not impervious to flue gases, this method is not only not approved but is prohibited in many places.

Lined Flues the Answer.

The solution is found through the use of the product known correctly as flue lining, not flue tile. Standard linings of fire clay, being at the minimum two feet in length, the number of exposed mortar joints for brickwork is reduced from 10 to 1. Being made of fire clay, they are unaffected by the flue temperatures and flue gases. The thickness of the walls of the chimney when such flue lining is used may vary according to type and location with four inches of brickwork as a minimum, though eight inches is preferable to conserve heat losses.

As a matter of common sense, all woodwork and other combustible material should be well insulated from the chimney. Once the chimney has been built tight and sound, it should of course remain so and therefore it must be built on solid foundations and should support no structural members of any kind which might become loosened or jar the chimney in any way.

National Board and Other Ordinances.

The National Board of Fire Underwriters has published an Ordinance for the Construction of Chimneys which is a very fine and comprehensive piece of work, and has been officially endorsed by the National Fire Protection Association and a number of other organizations. If this Ordinance were universally adopted and its provisions carried out, fires due to chimneys would be practically eliminated. It is also a fact that most, if not all cities of 25,000 population and many smaller cities have building codes in which provision should be made for the proper construction of chimneys.

Experience has shown that the different municipal building codes very seldom have the same stipulations. The writer made an investigation of building code requirements for the construction of chimneys in order to determine to what extent building code provisions were lax and fires could reasonably be attributed to that cause.

A questionnaire was prepared and sent out to cities in a selected territory and replies were received from 91 building officials. In order to secure complete information, the questions covered particularly the construction details which are liable to be the cause of fire.

Diversity of Municipal Requirements.

The tabulation of the replies was very illuminating in some particulars and quite astounding as evidencing the lack of uniformity in requirements of the different cities. The number of connections per flue allowed, which, as before stated, is a serious cause of chimney fires, ran from one to no limit. Twenty cities allowed only one connection while 44 cities allowed any number at all to each flue. Others allowed two, three, four, seven, one per floor, one per family and so on. The National Board of Fire Underwriters and other authorities recommend only one connection to each flue, mainly as a protective measure, and the investigation showed that this requirement was generally ignored.

On the other hand, 75 cities require flue linings as against 15 which do not require this recognized protection, although fire clay flue linings as recommended by the National Board are only definitely required in 23 of these codes.

Gas appliances are required to be vented in 50 out of the 91 codes but only 28 require that a masonry flue be used. Wherever there is any possible danger of fire from a flue for venting purposes, the flue, to afford the proper protection, should always be of masonry.

This investigation indicates that building codes are not as strict and the provisions are not as careful as they should be. It would therefore be possible to reduce the fire losses attributable to defective chimneys and flues by revising the various building codes and making their provisions agree with recognized best practice.

Building Codes and Inspection.

However, even though the provisions are lax, the entire responsibility cannot be placed on the building codes, as there are other factors which have an influence on the actual construction. It must be remembered that it is impossible for building inspection departments, as they are usually constituted, to supervise constantly all details of construction. Many houses are built without architects or supervision of an architect's office. Very often the workmen are not experienced in chimney construction and so even when properly designed, specified and "coded" the completed chimney may be defective.

One reason for this is a matter of construction methods and where very likely the proper method is not fully appreciated. In building a chimney each section of lining should be carefully placed on the section below with a thoroughly mortared joint surrounded by not more than two courses of brickwork, slushed in, to steady the lining; the brickwork should then be built up around the lining slushing in mortar between the brick and the lining as each course is laid with full bed and vertical joints. Unfortunately this method is not as quick or easy as building up the

brickwork and dropping the lining down. Consequently the latter method is most frequently used, the joints are not tight and the linings are not properly set with a tight filling of mortar all around.

Necessity for Careful Workmanship.

The contributary causes of fires due to chimneys may then be attributed first to lack of proper building code requirements and secondly to actual construction methods. Building codes are being constantly revised and by keeping the public and the city officials informed, proper regulations for the construction of chimneys can be and are being incorporated in codes. By supporting work of this kind, the individual can take his part in reducing the fire loss.

To ensure proper construction, once suitable regulations are in force, is another matter and is the particular obligation of those connected with the building industry. By specifying proper construction methods architects can help, by insisting on good workmanship the contractor can do his share, and by giving careful attention to actual construction the bricklayer or mason can accomplish his part in securing correct results. After giving this matter careful consideration the writer has come to the conclusion that the way to ensure these results is through somewhat drastic methods by insisting beforehand that all chimneys shall be tested on completion to determine whether or not they are tight.

Smoke Tests to Ensure Tightness.

If the mason contractor knows that he will not be paid until all flues are tested and proved tight, he will take extra precautions to see that all his workers understand that condition, and they in turn, realizing what it will mean to them to make it good if their work is defective, will take additional pains to do it well. In other words, flues would under this provision almost automatically become tighter than now generally built.

Most of the things mentioned in this article are known to and observed by the best bricklayers, but there are many others less experienced who have not given as much thought and attention as they should to the importance of safe chimney construction. For the latter's work a test is imperative. For the good bricklayers such tests would prove their fitness and afford protection against incompetent competition.

If each flue is given a thorough smoke test any leaks would be discovered and could be made good at once. It is important that the test should be made with the mason contractor and not by the heating contractor. Specifications frequently call for the latter to test flues before connecting heating apparatus and to "report any leaky flues for correction"—but by this time the mason may have left the building and perhaps have been paid, and, as is often the case, the building itself may have been plastered or so far finished that corrections are both difficult and costly

and so the conditions are tolerated in spite of the perpetual fire menace as well as the annoyance and added cost of heating.

Recommendation for Testing Flues.

It is suggested that all specifications for building construction contain a clause under "masonry work" based on the following recommendation for the testing of chimneys:

> Before the scaffolding is removed from around any chimney and before any chimney walls or breasts are plastered, but not until after the mortar has seasoned, each flue shall be given a separate and thorough smoke test by the mason contractor. The tests shall be made in the presence of the mason contractor, the heating contractor and the architect or their representatives.
>
> Leaks into adjacent flues shall be especially looked for and not more than one flue shall be tested at one time.
>
> Any leaks which may develop shall be promptly made tight before the chimney work will be accepted as satisfactory.

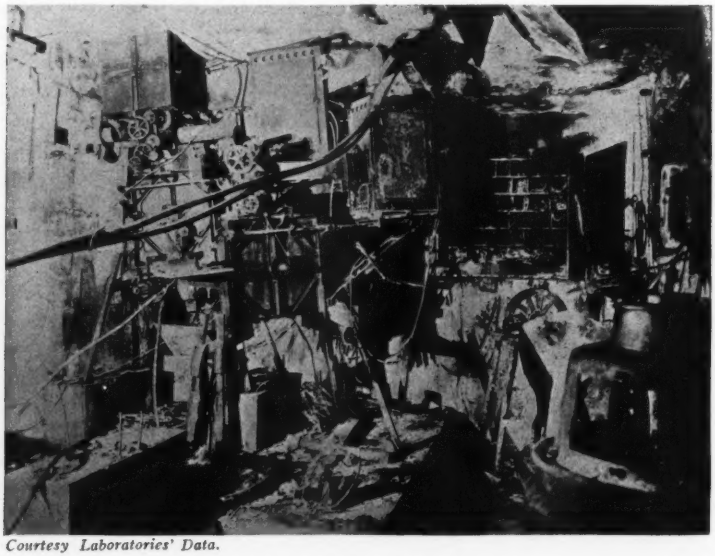
One method for conducting this test is to build a smudge fire of paper, straw, wood or tar paper at the base of the flue. If the chimney does not draw well at first the column of air in it should be forced out; this may be done by firing a roman candle in the flue. When a dense column of smoke is ascending, tightly block the one outlet by placing a wet blanket over it. If there are leaks at any points, they will be revealed by the issuance of smoke. Such leaks may be into adjoining flues or directly through the walls or between the walls and the lining.

A chimney which shows a leakage should never be accepted until the defect has been remedied. As the stopping of a leak even immediately after the chimney is completed is usually very difficult, it will well repay the time required by the contractor or foreman to watch the construction closely as it progresses and the care given by conscientious workers during erection.

Why Not Inspection and Certification of Flues?

Fires caused by electricity are classed as only partially preventable, yet with the widespread use of electricity its use is not responsible for so great a loss as defective chimneys and flues. This can be attributed in part to the National Electrical Code which regulates the installation of electrical wiring and appliances. But even of more importance in lessening the loss from this cause, especially in all new construction, is the further fact that all electrical installations must be inspected by organizations having jurisdiction and that a certificate must be issued by them before fire insurance policies will be written on the building. Why not the same provision as to every chimney built? The question then naturally arises, why not a National Chimney Code? The writer firmly believes that some day soon such a code will be a reality.

To design and build chimneys according to the provisions of such a code would be perfectly feasible. To inspect all flues and when found tight to issue a certificate to that effect and to make all insurance contingent upon such certificates is surely also but common sense. The Chimney Ordinance of the National Board of Fire Underwriters could serve as a basis on which a National Chimney Code could be drawn up and once it was prepared and recognized as authoritative, it could be put into force just as the Electrical Code now is. With the backing of fire underwriters, fire prevention organizations, architects, contractors, workmen and owners, it would not be long before the fire losses due to defective chimneys and flues would be practically eliminated with respect to new construction.



Courtesy Laboratories' Data.

A Film Booth Fire.

This picture shows the interior of a motion picture projection booth at a theatre after 6,800 feet of film had burned in it.

The film caught fire at the lower loop of the machine while the machine was running, the fire being caused by heat from the arc. A second reel of film, which the operator had in his hand, ignited from the first film. He threw this second film toward the door of the booth, blocking his escape there, but saved himself by jumping through a window to the cement sidewalk 12 feet below, landing with slight injuries. To throw the burning reel through the window would have blocked the exit from the theatre for patrons. The fire was confined to the booth.

The Poker as Priest.

Among the live creatures that crawl about this star the queerest is the thing called Man. This plucked and plumeless bird, comic and forlorn, is the butt of all the philosophies. He is the only naked animal; and this quality, once, it is said, his glory, is now his shame. He has to go outside himself for everything that he wants. He might almost be considered as an absent-minded person who had gone bathing and left his clothes everywhere, so that he has hung his hat upon the beaver and his coat upon the sheep. The rabbit has white warmth for a waistcoat, and the glow-worm has a lantern for a head. But man has no heat in his hide, and the light in his body is darkness; and he must look for light and warmth in the wild, cold universe in which he is cast. This is equally true of his soul and of his body; he is the one creature that has lost his heart as much as he has lost his hide. In a spiritual sense he has taken leave of his senses; and even in a literal sense he has been unable to keep his hair on. And just as this external need of his has lit in his dark brain the dreadful star called religion, so it has lit in his hand the only adequate symbol of it: I mean the red flower called Fire. *Fire, the most magic and startling of all material things, is a thing known only to man and is the expression of his sublime externalism. It embodies all that is human in his hearths and all that is divine on his altars. It is the most human thing in the world; seen across wastes of marsh or medleys of forest, it is veritably the purple and golden flag of the sons of Eve. But there is about this generous and rejoicing thing an alien and awful quality: the quality of torture. Its presence is life; its touch is death.* Therefore, it is always necessary to have an intermediary between ourselves and this dreadful deity; to have a priest to intercede for us with the god of life and death; to send an ambassador to the fire. That priest is the poker. Made of a material more merciless and warlike than the other instruments of domesticity, hammered on the anvil and born itself in the flame, the poker is strong enough to enter the burning fiery furnace, and, like the holy children, not be consumed. In this heroic service it is often battered and twisted, but is the more honourable for it, like any other soldier who has been under fire.—*G. K. Chesterton.*

Steam Protection for Oil Tanks.

By G. O. Wilson.

Standard Oil Company of California.

It has been known for many years that if enough steam is supplied to a confined space containing oil vapors, it will extinguish a fire, or prevent the vapor mixture from burning in that space. Consequently steam smothering has been widely used as fire protection for oil tanks since the early days of the oil industry. It has been commonly felt that with a "full head of steam" turned into the vapor space of a tank, that tank was protected against ignition by exposure fires and to a considerable extent against electrical storms.

However, a number of cases have been reported during the past years in which tanks or agitators that had apparently been quite well steamed, were ignited. These occurrences raised a question as to how much steam is really needed to protect a tank. A search of the rather meager literature on this subject yielded little information. Some theoretical computations were made, and it was attempted to check these with some small scale laboratory tests; but these miniature tests seemed to show much less steam required than the computations indicated. Our Company accordingly decided that the subject was of sufficient importance to justify a thorough investigation, on a large enough scale to give results comparable with actual field conditions. The problem was divided into two parts:

(1) Measurement of amount of steam required to make a gaseous mixture incombustible.

(2) Determination of the time required to reach this steam concentration in full size tanks.

The Test Equipment.

For the first tests the apparatus shown in Fig. 1 was used. This consisted of a 110-gallon drum with the top head removed and replaced with a loose water sealed bell cover. With this equipment the fresh air in the tank at the start should be drawn out, bubbled through a graduate containing light gasoline, and returned to the tank. From previous experiments it had been learned that about 25 cu. ft. of vapor is produced per gallon of liquid evaporated under the conditions prevailing in these

---

This article is taken from a paper presented by Mr. Wilson, Secretary, Consulting Board of Engineers, Standard Oil Company (California), at the meeting of the American Petroleum Institute (Member N.F.P.A.), in Los Angeles, in January, 1926.

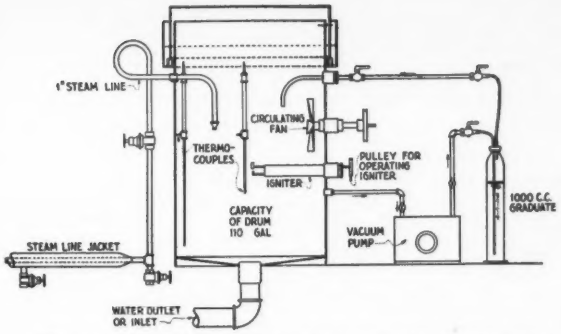


Fig. 1. Apparatus used for tank steaming tests, constructed from 110-gallon drum.

tests. Knowing this factor, it was easy to compute the number of cubic centimeters that had to be bubbled off to charge the tank with a given percentage of gasoline vapor. A fan was installed inside the test tank to insure a uniform mixture throughout.

The development of a reliable igniter was not a simple problem. An ordinary spark plug was first tried, but this was discarded after a few preliminary tests, on account of the difficulties due to short-circuiting when steam was introduced. The wipe spark apparatus shown was finally developed. This was connected to a standard 110-volt circuit through resistance which permitted 30 amperes to flow when the contacts were closed. This gave a very "fat" hot spark when the steel spring wiper left the spark point.

Steam was introduced through a nozzle, pointed toward the bottom of the tank as steam is lighter than an air-gasoline vapor mixture. To measure the quantity of steam introduced, thermocouples (electrical instruments for measuring temperature) were placed in the tank, as shown. Knowing the temperature within the drum, it was possible to compute from the steam tables the percentage of steam present at any given time.

As a preliminary check on the performance of this equipment, tests were run without any steam in the drum—just gasoline vapor-air mixtures of varying concentrations. The results checked figures given by the Bureau of Mines and other authorities in that no ignition occurred when the vapor concentration was less than about 1¼% or more than about 6½% by volume. With mixtures just within these limits very slow combustion occurred—just enough to splash a little water out of the seal of the roof, but not enough to lift the cover appreciably. However, as the theoretically correct mixture of gasoline vapor and air for complete

combustion was approached, about 3% of gasoline vapor by volume, the firing became very sharp and decisive.

Having demonstrated by these preliminary tests that the equipment provided could be depended upon to cause ignition whenever a combustible mixture was present, the steaming tests were started. The procedure followed was to fill the tank with a mixture of gasoline vapor and air, supply steam until the thermocouples indicated that the desired concentration was reached, and then attempt to fire the mixture by operating the wipe spark igniter. If ignition occurred, more steam was used in the next test. If the mixture did not burn after sparking had continued for some time, the test was repeated a number of times, slightly varying the proportion of gasoline vapor and air, in order to make sure that the tank was charged at the start with the most combustible mixture.

Amount of Steam Required to Prevent Ignition.

The preliminary laboratory tests had indicated that a concentration of about 20% steam, by volume, which is attained when the temperature has reached 140° F., would prevent combustion. These tank tests were accordingly started by steaming to about that temperature; but with this much steam in the tank, it was found that ignition occurred almost every time the spark was struck. However, the combustion was more muffled than with an unsteamed mixture. The temperature was gradually increased in successive tests; and when 160° F. had been reached, corresponding to a steam saturation of about 30%, ignition had become very uncertain. It seldom occurred the first time the spark was struck; and in a number of tests no ignition could be obtained even by operating the wipe spark as many as 100 times. Some 30 tests were run at temperatures between 160° and 170°. One very weak ignition occurred at 163°, and one other so slight as to be barely perceptible at 166°. Absolutely no ignition could be obtained at temperatures higher than 166°.

In the light of these tests, it appears that to make a combustible mixture safe, it should be steamed to a temperature of at least 166°, or say in round figures 170°, which corresponds to a saturation of about 40% of steam by volume. This applies to a gasoline-air mixture of just the right proportions for complete and rapid combustion—about 2½% to 3½% of gasoline vapor by volume. Where the mixture is richer or leaner than this, less steam will be required; 20%, or a temperature of 140°, may be enough to give protection to a large percentage of tanks; but to be safe under any conditions, the higher saturation of around 40% is necessary.

Having learned with this model apparatus the proportion of steam necessary to make the vapor space in a tank incombustible, the next step was to investigate the time needed to reach this saturation in tanks of

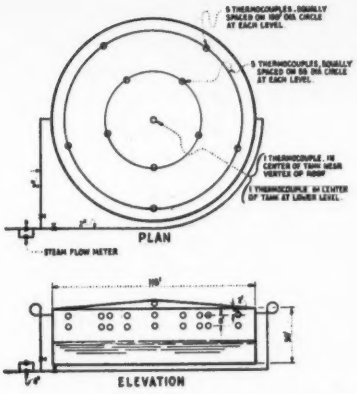


Fig. 2. Equipment used for measuring steaming rate in 55,000 Bbl. Tank.

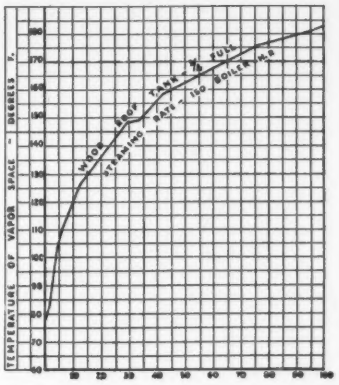


Fig. 3. Steaming rate observed in typical test.

different sizes—with steel and wooden roofs, and with steam being supplied at varying rates likely to be available.

Fig. 2 illustrates typical equipment used for one of these tests. In this 55,000 barrel tank (115 ft. diameter x 30 ft. high) about half full of oil, 22 thermocouples were suspended at various points in the vapor space, and steam was turned in through two typical steam smothering connections opposite each other near the eaves of the tank. The rate at which steam was being supplied was measured by an orifice-meter, and readings were taken on all thermocouples at intervals of two or three minutes.

Appearances Deceitful.

It should perhaps be stated at this point that the "fog" which is commonly spoken of as steam, will not prevent ignition of a combustible mixture. Previous observations that had been made in empty tanks to which steam was being injected had shown that 5 or 10 minutes after the steam was turned on, the tank would be practically full of swirling clouds of "fog"; but it was also observed that when this "fog" came in contact with the face it felt cold. The tests in the small drum previously described early demonstrated that a gaseous mixture was not incombustible until enough actual uncondensed steam was present to raise the temperature in the vapor space to around 170°. Hence, in these full scale tests, on large tanks, we again relied for an indication of the degree of safety that had been attained, on thermocouples which measured the temperature in various parts of the vapor space and thus showed the amount of actual uncondensed steam present.

Fig. 3 shows the results of a typical test run in this way. The tank used for this test had a wooden roof and was three-quarters full of oil.

Steam was supplied at rate of about 150 boiler H.P. The temperatures plotted on this curve were those indicated by the thermocouple at about the middle of the vapor space; for it was found in this and other tests that with steam coming into the tank at high velocities the turbulence produced resulted in practically uniform heating of the vapor space, provided the oil level was not more than 12 ft. or 15 ft. below the top.

The Time Required to Secure Safe Percentage of Steam.

It will be noted from Fig. 3 that the temperature rose quite rapidly at the start; but as the space inside warmed up, the radiation losses through the shell became greater, so that the rate of heating gradually slowed down. The safe temperature of 170° was not reached until steam had been going into the tank, at the high rate of 150 boiler H.P. used in this test, for one hour and five minutes.

A considerable number of tests were run in this way, with various steaming rates and oil heights, and in tanks with both steel and wooden roofs. From the results obtained we were able to construct an equation by means of which the rate of increase in steam concentration can be computed for any given conditions—size of vapor space, kind of tank roof, and rate of steaming. Fig. 4 shows a number of curves plotted from this equation, for a 55,000 barrel tank. For all of these curves the steaming rate assumed was the same as in the typical test previously described—150 boiler H.P. Instead of plotting temperatures, as was done in Fig. 3, the percentage of steam in the vapor space, which is really the important consideration, has been plotted in Fig. 4. The curves show that with 150 boiler H.P. available for steaming a 115 ft. x 30 ft. tank, the time required to reach 40% saturation of the vapor space will vary from one-half hour to three hours, depending upon the fullness of the tank and the type of roof.

Even a half hour is a long time to get a tank into safe condition, when 150 boiler H.P. is being used for this purpose; and of course by the end of three hours the hazard against which we are attempting to protect by steam smothering will probably have long since passed. In the light of these test results, it is easy to understand how tanks which had been steamed for some time could easily have been ignited if subjected to exposure fires, static sparks, or atmospheric electrical discharges.

In the course of the tests on non-gas-tight wooden roof tanks, it had been observed that steam, or rather "fog," began to show at the hatches and roof cracks a few minutes after the test started; before the thermocouples inside showed that any effective concentration of steam had been obtained. To an observer standing on the ground, there appeared to be practically as much steam leaking out during these early stages of the

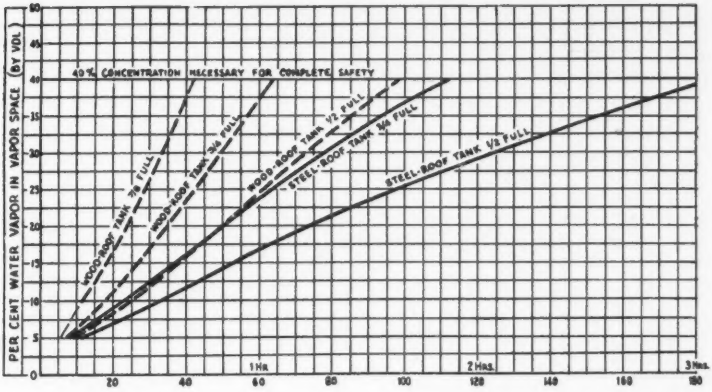

PER CENT WATER VAPOR IN VAPOR SPACE (BY VOL.)
40% CONCENTRATION NECESSARY FOR COMPLETE SAFETY
WOOD-ROOF TANK 7/8 FULL
WOOD-ROOF TANK 3/4 FULL
WOOD-ROOF TANK 1/2 FULL
STEEL-ROOF TANK 3/4 FULL
STEEL-ROOF TANK 1/2 FULL
1 HR.
2 HRS.
3 HRS.

Fig. 4. Rate of saturation of vapor space in 55,000 Bbl. Tank (115 ft. diam., 30 ft. high). Steaming rate 150 Boiler H.P.

test as when the concentration had increased to 20% or 30%. This created the impression that there might be a local concentration of steam, just under the roof; but since, as the thermocouples placed close to the roof showed that this was not the case, it was concluded that the appearance of the tank being steamed evidently gave a very unreliable indication as to the degree of safety that had been attained.

To check up more definitely on this point some further tests were run with the model tank, with minor changes in the cover consisting mainly of inserting a 6 in. outlet, and resting on top of it a loose blind flange, with a cord attached so that it could be jerked off when desired. A torch was mounted so that an operator at a distance could bring it up close to this vent after it had been uncovered.

A number of tests were run with this apparatus which demonstrated that even though a tank has been steamed to such an extent that copious clouds of "fog" will issue from the vent when this is uncovered, a flash-back is liable to occur if a flame is brought near the open vent before the safe concentration of 40% of steam has been reached inside the tank. These tests incidentally demonstrated that mixture which has not been steamed to a safe condition is just as liable to be ignited by an exposure fire as by the hot electric spark used in the previous tests. In some tests where the tank has been steamed to a safe condition so that ignition would not occur when the torch was brought up to the vent, the steam was shut off, and inside of about 30 seconds, enough condensation had occurred so that the mixture again became combustible and a flash-back occurred.

New Questions Raised.

The tests described thus far furnished definite answers to the questions that were asked at the start; they showed that—

(1) A steam concentration of approximately 40%, corresponding to a temperature of 170°, must be reached to make a combustible mixture of gasoline vapor and air non-flammable.

(2) A relatively long time is required to reach this concentration in the vapor space of tanks under average conditions.

(3) The appearance of considerable quantities of "fog" issuing from roof cracks or hatches is no sign that a tank is in a safe condition.

But these very answers served to raise new questions:

(1) If steam is so relatively slow and unreliable in providing the desired protection, why has it been regarded for so many years as a safeguard which should not be omitted from any tank within the range of a boiler plant?

(2) If it is of such doubtful value, should we continue to use it for tank protection?

An attempt to answer these questions requires first of all that we take into account the change in the type of tank roof construction that has occurred quite generally in the past few years. Until recently a great majority of our large storage tanks were equipped with wooden roofs, covered either with galvanized iron or tarred paper. In but few cases were such roofs even approximately gas-tight. The wind generally blew into the cracks on one side of the roof; and a mixture of air and oil vapor seeped out through those on the other side. This created a fire hazard in two ways. First, the combustible vapors leaking out through a multitude of openings in the roof were liable to be ignited by any stray brand or electrical discharge; and second, the fresh air leaking into the tank diluted the vapor mixture inside the tank to combustible proportions.

Under these conditions, in case of a threatened lightning storm or exposure fire, about the only hope of protection was to inject steam as fast as possible. If the tank were quite full, or if it were near enough to the boiler plant so that a high rate of steam delivery was possible, or if the roof were fairly tight, so that not enough air had leaked in to dilute the mixture to the point of maximum combustibility, there was a fair chance that, in a relatively short time, a safe condition would be reached.

As a protection against atmospheric electrical discharges, steaming such loose-roofed tanks probably had another good effect. Condensed steam may collect on the under side of the roof and furnish a temporary electrical connection between the metal sheets with which it is covered. Under these circumstances, static discharges occasioned by a bolt of

lightning in the near vicinity may be conducted by the water, instead of producing sparks in jumping from plate to plate.

Under the circumstances, it is easy to see how steam established its reputation as a safeguard for oil tanks of the old type, with roofs that were far from gas-tight. But in the light of our test results we must realize that there may be conditions where safety is not attained by this process until steam has been going into the tank for a long time.

Protection of Gas-Tight Steel Tanks.

When we consider a tank with a modern gas-tight steel roof, we find the picture entirely different. In the first place, since there are no cracks for the wind to blow through, the mixture inside is much more likely to be saturated with oil vapors to such an extent that it will not burn. A graphic demonstration of what this may mean was afforded in a fire at Monterey a year or so ago. Six tanks containing crude oil burned; and, as is characteristic of crude oil fires, each boiled over during the course of the fire. On the down-hill side of these tanks stood a 7,500 barrel tank containing gasoline. When the flaming oil from the first boil-over flowed down around this tank, the sudden heating of the vapor space pushed off the loose water-seal cover of the roof manhole; and the vapors issuing from this 11 in. opening burned as a flame which at times reached a height of several feet.

When the boil-over oil around this tank had burned up, and the tank started to cool off, this flame died down and quietly snuffed itself out. The vapor inside the tank was too rich to burn; and as there was no outside heat to push this vapor out of the manhole, there was nothing to feed the fire. This experience was repeated a number of times during the 24 hours that the crude oil tanks burned; immediately after each boil-over a bright torch could be seen burning at the manhole of the gasoline tank; and each time the boil-over oil burned out, the flame died down and snuffed itself out. It was reported that after the fire a gauge of the tank showed that less than 1 inch of gasoline had been evaporated.

Disadvantages of Steam in Gas-Tight Steel Tanks.

When a tank contains a vapor mixture as rich as did this gasoline tank there is obviously nothing to be gained by forcing steam into it. As a matter of fact, such injection of steam might do actual harm, in either of two ways. First, it would force some of these rich vapors out through the vent, perhaps to be ignited by any exposure fire that might be near. The experience at Monterey demonstrated that such a vent fire may be harmless; but it is certainly undesirable, and under certain conditions might so warp the roof that holes would open up through which air could leak in and dilute the mixture to a combustible condition. And such a vent fire is

Fig. 5. Gasoline vapor-air fire at breather valve.

less likely to occur if the tank is allowed to stand untouched, than if a large amount of vapor is forced out by the injection of steam.

The second and more serious difficulty that may be encountered if steam is injected into a tank containing a rich mixture, develops in case the steam is for any reason shut off while there is still an exposure fire in the vicinity. As observed in the tests with the small drum, when steaming stops, condensation occurs very rapidly, and considerable quantities of air are thus drawn into the tank. This air will dilute the mixture immediately under the vent to a combustible condition. Furthermore, the in-draft may tend to suck flames from any nearby exposure down the vent.

Realizing these facts, it is evident that by injecting steam into a gas-tight tank where the mixture was originally too rich to burn, one places himself in the unenviable position of the fellow who caught a bear by the tail. He has to hang on,—and this may not always be possible, in case of broken steam lines, need for steam to transfer oil, or other contingencies.

There are, of course, some conditions in which the vapor-mixture inside a gas-tight tank will not be too rich to burn, even though there are no leaks in the roof for the wind to blow through. For example, the oil in the tank may have a low enough vapor pressure so that it will not saturate

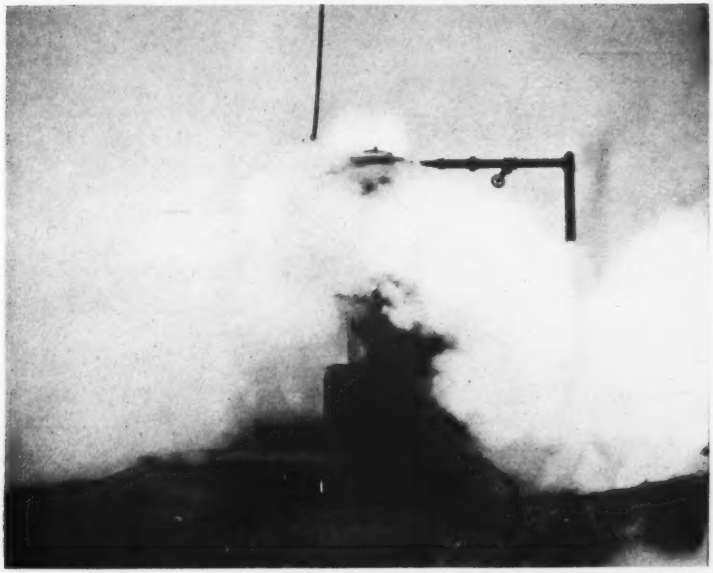


Fig. 6. Fire at breather valve extinguished by steam (see Fig. 5).

the space above it sufficiently to produce this too-rich mixture. And even in those tanks that do normally contain a too-rich mixture, air will be drawn in when the tank cools off at night, or when oil is pumped out of the tank. We have made a great many observations, particularly on gasoline tanks, which have indicated that the dilution which takes place in this way is ordinarily confined to a comparatively small volume under the vent. In fact, unless the air is drawn in quite fast by a rapid delivery of oil from the tank, diffusion will result in keeping practically the entire vapor space of a gasoline tank in a condition too rich to burn.

There are thus relatively few conditions where we have a combustible mixture inside a gas-tight tank. When such conditions do exist, it may, at first glance, seem that here is a case comparable to that of the loose-roofed tank, and that the best thing to do is turn in steam as fast as possible in case the tank is exposed to fire, and hope that there will be time enough to get in a sufficient amount to make the tank safe before the flame actually comes near the vent. Further consideration, however, shows that this is not the best plan for a number of reasons.

The fact that the tank has a steel roof, which radiates heat much more rapidly than the old wooden roofs, will result in a much longer time being required to get a safe concentration of steam inside the tank.

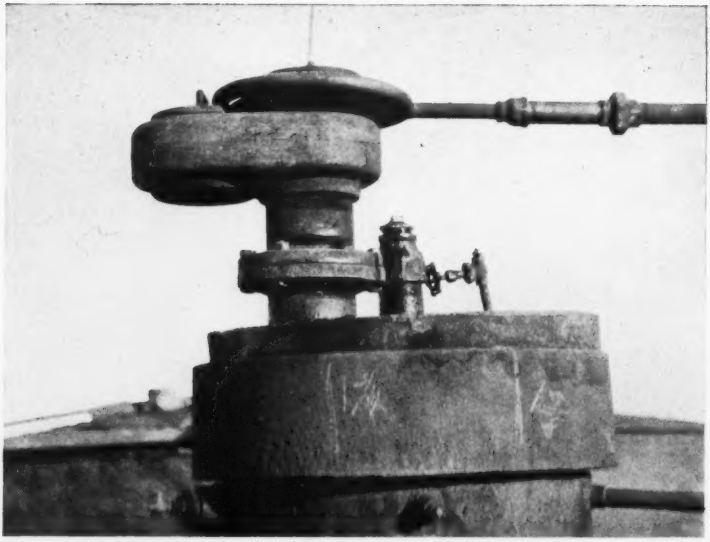


Fig. 7. Steam smothering ring for breather valves (see Figs. 5 and 6 for method of use).

Also injection of steam will immediately start forcing a combustible mixture out through the vent; and this presents a more serious hazard than in the case previously discussed, when a mixture inside the tank was too rich to burn. For if these issuing vapors should become ignited they might flash back into the tank.

Steam Smothering Jets Applied at Vents.

It is evident that there are disadvantages to injecting steam into a gas-tight tank in which the mixture is combustible, just as there were in the case where the mixture is too rich to burn. This does not mean, however, that steam has no place in the protection of gas-tight tanks. As a matter of fact, we found by a number of tests of steam smothering jets applied at the vents of such tanks, that this form of steam protection is likely to be more effective than the best protection we were ever able to give the old loose-roofed tanks under most conditions. These tests showed that with a very moderate rate of steam flow—one-quarter to one-half the rates used in the previously described tests where steam was injected into the tanks—we could extinguish a hot vent fire, or prevent a flash-back in the case of combustible mixtures issuing from the vent. And the best part of it is that this protection is available a few seconds after the steam

Fig. 8. Steam prevents ignition by flaming torch of gasoline vapor-air mixture at tank vent.

reaches the vent instead of having to wait from a half hour to three hours, which we found to be the case when steam was injected into the tank.

Fig. 5 shows a test in progress on one of our present single-port type breather valves discharging 27,000 cu. ft. per hour of rich gasoline-vapor —air mixture. This rate of discharge would occur only if a tank containing very volatile gasoline were being pumped into, at a rate around 5000 barrels per hour, which is a condition more severe than anything likely to be encountered in practice. Fig. 6 shows the cloud of steam which extinguished such a fire a few seconds after it was turned on at a rate of about 70 boiler H.P., and Fig. 7 illustrates the slotted ring surrounding the outlet of the valve through which the steam was supplied.

In these tests we were extinguishing fires which were burning at vents through which rich mixtures were being expelled. Other tests were made with a combustible mixture which was expelled through the open vent, and steam delivered from the jet to prevent a flash-back. The flaming torch shown in Fig. 8 was held in various positions around the vent, but no flash-back occurred as long as the steam rate remained higher than about 30 boiler H.P. In some tests a flash-back occurred when the rate was reduced to 20 boiler H.P.

A considerable number of tests of this kind were run on various types of vent. They all lead to the conclusion that a steam jet delivering from 30 to 50 boiler H.P. will extinguish a vent fire of rich vapors, or will prevent a flash-back of a combustible mixture, provided the steam is thoroughly distributed around the vent opening. Higher steaming rates may be necessary under especially severe conditions; but a jet delivering 75 boiler H.P. was able to protect vents discharging as much vapor as would ever be likely to be encountered in practice.

The detail in connection with the installation of these jets which might appear to be of minor importance, but which really demands careful consideration, is the fact that they should not be so placed as to discharge the blast of steam directly into the vent; for if this is the case a surprising amount of back-pressure may build up in the tank; enough to open any emergency relief hatch with which the tank may be provided, which is just what should be carefully avoided.

The tests described have demonstrated that smothering jets can be successfully applied to a number of different types of tank vents and breather valves. However, this form of steam protection is a rather new development and further experience will doubtless disclose many improved methods of applying such jets to the various forms of tank breather valves and vents that are in service.

Summary.

The various tests that have been described have brought out the following facts:

1. A considerable amount of steam must be introduced to a gaseous mixture to make it incombustible. When gasoline vapor and air are mixed in just the right proportions for complete combustion—about 3% of gasoline vapor by volume—40% of steam must be introduced to obtain safe conditions; this corresponds to a temperature of about 170° F. throughout the vapor space.

2. With steam being supplied at 150 boiler H.P. to the vapor space of a 55,000 barrel tank, a period ranging from one-half hour to three hours will be required to reach this safe steam concentration, even with steam being injected at a rate of 150 boiler H.P.

3. The appearance of steam or "fog" issuing from the roof cracks or hatches of a tank is no indication that the space inside has been steamed to a safe point.

4. If a tank containing volatile stock is equipped with a modern gas-tight steel roof, the vapor space inside will be either

(a) Filled with a mixture too rich to burn, in which case there is nothing to be gained by injecting steam; and doing so may actually introduce a hazard; or

(b) Under comparatively rare conditions, it may be filled with a combustible mixture, in which case a long period of steaming at a high rate is generally necessary to attain a safe condition, during which combustible gases will be expelled from the vent.

5. Regardless of the condition inside the tank, the only place where a gas-tight tank can be fired is at the vent. A steam jet delivering 35 to 50 boiler H.P., if properly distributed around the vent, will extinguish a vent fire, or prevent a flash-back into a combustible mixture under ordinary conditions. Extreme conditions can be controlled with 75 boiler H.P.

6. Such vent protection is available a few seconds after the steam reaches the nozzle, instead of having to wait for periods that might be as long as several hours, when steam is injected into the tank.

In conclusion, it may be pointed out that the practice of injecting smothering steam into the vapor space of tanks has probably filled a useful place in the fire protection measures available for tanks with non-gas-tight roofs. The modern gas-tight steel roof needs little protection of any kind; but where steam is used it can apparently do the most good in the shape of a jet protecting the vent.

ACKNOWLEDGMENTS: The tests described in this paper were carried on under the general direction of Mr. H. H. Hall, Chief Engineer, Standard Oil Company (California). They were actually conducted by Messrs. J. A. Ryan of the Manufacturing Development Department, H. E. Geyer of the Engineering Department, and D. W. Rohrback of the Pipe Line Department—to all of whom as well as to Mr. M. B. Anfenger of the Engineering Department, the writer is indebted for suggestions regarding the paper.

Private Fire Service Charges in Chicago.

Reprinted from "Chicago Commerce," published by The Chicago Association of Commerce.

Presenting a united front against the private fire protection charges as contained in the Chicago city ordinance now in force, committees of The Chicago Association of Commerce and the Illinois Manufacturers Association met with Commissioner of Public Works Albert A. Sprague, on February 13, to emphasize in no unmistakable terms their belief that the charges are unfair and of a penalizing nature.

Frank D. Chase (Member N.F.P.A.), chairman, made the first presentation on behalf of the Chicago Association of Commerce. He presented the following argument:

Such equipment serves all citizens by making the city more safe from conflagration hazard and assessment of service charges for private fire protection constitutes class legislation, penalizes business, and discourages it from adequately protecting its properties. Imposition of service charges tends to increase the burden upon Chicago's fire department, operates to increase rather than lower insurance costs, interferes with locating new industries in Chicago and discourages existing industries from remaining or expanding their facilities. We believe that business and industry should pay the actual cost of securing connections with city mains for private fire protection, the cost of suitable meters or other water measuring devices and the cost of water used for private fire protection, except where such equipment may be employed to protect a building from fire in adjacent structures or where, in the judgment of the Chicago Fire Department, use of a large amount of water is necessary to prevent a conflagration.

It was evident at the conference that business men and manufacturers are united against the idea of placing an annual charge on fire protection equipment in buildings. It will be seen below how excessive the charges in the present ordinance are. The Association had at the conference a large amount of evidence on this point showing how some firms in the city would have to pay several thousands of dollars a year merely because they own special fire protection apparatus. One local wholesale house owning sprinkler systems, fire hydrants, etc., has figured its annual bill at close to $4,000, whereas last year the charge was around $5.

Commissioner Sprague is in favor of an amended ordinance which places a charge on a connection with a city water main. He stated at the conference that this would result in approximately $264,000 a year revenue.

EDITOR'S NOTE: A letter from Commissioner Sprague to the N.F.P.A. Executive Office received just before the QUARTERLY goes to press indicates that the charges referred to in this article will be somewhat reduced.

The Schedule of Rates.

The following extract from pages 1328 and 1329 of the journal of the proceedings of the City Council, special meeting, September 1, 1925, gives in full the new rates which are now in force.

Rates for private fire protection. Service charges for connections through which fire protection may be furnished, no matter whether said connections are equipped with meters which will accurately register all water passing through said connections, or with devices capable of detecting and recording every instance in which water may be drawn through said connections, shall be as follows:

	Per annum
For each 2-inch connection	$ 21
For each 3-inch connection	42
For each 4-inch connection	60
For each 6-inch connection	84
For each 8-inch connection	180
For each 10-inch connection	240
For each 12-inch connection	300

The service charges above referred to or enumerated, whether for metered connections or for those having devices for detecting and recording the use of water, shall be payable in addition to the annual charges for sprinkler heads and for fire hydrants or hose connections hereafter in this section enumerated:

For sprinkler heads:	Per annum
Minimum charge for sprinkler heads	$20.00
For each sprinkler head	.04

The above charges for sprinkler heads to apply, no matter whether said heads be supplied from a fire protection tank or a pump or other equipment on the consumer's premises, so long as water may be drawn from the water works system of the city of Chicago for the supply of said pump or said tank or other equipment.

For private fire hydrants or hose connections:

Minimum charge for fire hydrant or hose connection....$20 per annum

For each hydrant having two 2½-inch hoze nozzles, or two 2½-inch hose nozzles and one 4-inch steamer nozzle, or two or more nozzles of larger size .....$30 per annum

For each hydrant having a single 2½-inch hose nozzle..$20 per annum

For each hose connection 2½-inch or larger.....$20 per annum

For each hose connection 2-inch or smaller.....$10 per annum

For other special water fixtures or for any other special or unusual use of water for which no charge has been specified, the commissioner of public works shall determine the amount to be charged for such special fixtures and for such use of water, such charge to be based upon an estimate of the amount of water used.

New Schedule Proposed.

The city has already taken cognizance of the "inquiries and protests" received because of this new schedule of rates, as a letter received from Commissioner of Public Works Sprague indicates. The commissioner advised that John Ericson, city engineer, had recommended a new schedule

of charges to supersede these set forth in the ordinance of September 1st. These place all the charge on the connection and wipe out the charges on hydrants, sprinkler heads, etc. Mr. Ericson's proposed charges are advanced as more "equitable."

Mr. Sprague's letter containing recommendations by the city engineer is in part as follows:

The present ordinance provides for certain charges for private fire protection connections, hydrants, hose connections to standpipes, and sprinkler heads.

It is now proposed to request amendments which in this case will place all the charge on the connection. This seems desirable from the interest of both the city and the owner, because it seems more equitable and simplifies the assessing, accounting and collecting of the charge.

In lieu of the present various charges as contained in section 4130 of the ordinance the following charges are proposed:

For each ¾-inch connection	$ 20 per annum
For each 1-inch connection	30 per annum
For each 1½-inch connection	40 per annum
For each 2-inch connection	50 per annum
For each 3-inch connection	100 per annum
For each 4-inch connection	150 per annum
For each 6-inch connection	300 per annum
For each 8-inch connection	600 per annum
For each 10-inch connection	1000 per annum
For each 12-inch connection	1500 per annum
For each 16-inch connection	2500 per annum
For each 18-inch connection	3500 per annum
For each 20-inch connection	5000 per annum

It is believed, and courts and public service commissions in general have upheld this view, that, since a utility company is put to an extra expense to provide means to serve such connections, a charge therefor is proper. Representatives of the National and the Chicago boards of underwriters have been conferred with, and they have expressed the opinion that such a charge can justly be made.

Water used through a private fire connection for fire protection purposes is not charged for, the cost being *distributed among* all consumers of water in the way of water rates.

It must be borne in mind that the making of the bare connection and the furnishing of the water through such a connection for fire purposes do not represent the only expense, but that the entire system must be so designed that in cases of such connections the city must provide a system that is capable at all times of supplying the quantity of water that such a connection can convey.

In the application of the charges to concrete cases it is quite certain that the proposed charge for the connection will be but a small fraction of the other annual charges against the private fire protection system that the property owner has to pay. An owner by virtue of his private fire protection on installation has returned to him in the way of reduced premiums his capital investment in seven or eight years. He received by the connection to the distributing system a means by which his equipment may be made effective, and a charge against the connection does not seem unjust.

Chicago receives its revenue for the operation, maintenance and extension of its water works system from the sale of water and assessments, and does not spread a tax for that purpose. These revenues must be sufficient to meet the expenditures for operation and extension, and this has not been the case for the past five years. An increase in rates has therefore been necessary and the new ordinance effects this increase. At the same time other conditions have been included in the ordinance which are meant to more evenly distribute the expense which heretofore has not been the case.

It is believed when all concerned know all the facts on both sides that the ordinance will be found to be free of alleged unreasonable features.

Another Personal Liability Decision.

The court records of another decision upholding the principle of liability for preventable fire have been received by the N.F.P.A. Executive Office.

On April 14, 1925, a fire occurred in Wyoming (Grand Rapids), Kent County, Michigan. The fire was caused, according to the testimony, by the negligent operation of a furnace in the basement of a grocery store; rubbish had been allowed to accumulate near the furnace and the furnace door was left open. It spread to an adjoining store in the same building which was divided only by a wood lath and plaster partition.

The tenant of the adjoining store, Jacob Hazewinkel by name, brought suit against Clarence Thomas and Joe Heuvelhorst, the proprietor and operator of the store where the fire originated, for $6,590.09, the value of his stock and fixtures and damages due to his loss of trade. The case was tried before a jury in the Circuit Court of Kent County, in Grand Rapids, Michigan, on May 21, 1925, and the plaintiff Hazewinkel secured judgment of $5,000. (Judgment No. 29243.)

The following extract from Judge Wm. B. Brown's charge to the jury summarizes the interesting features of the case as brought out by the evidence.

Now, the essential elements in this case to be established by the plaintiff are: that this fire was caused, the burning of the plaintiff's part of this store and his stock and the injury that he claims here, was caused by a fire which started on the Thomas side of this basement, and that that fire was caused or started by reason of the negligence of Joseph Heuvelhorst in the manner in which he ran the furnace and accumulated this rubbish around the furnace and allowed it to be there while the furnace had a fire in it. . . .

The second element is that the plaintiff himself was guilty of no negligence which contributed to the fire, such as allowing it to burn if he had ample time and a person by the exercise of ordinary care could have extinguished the fire by trying to do so at the time when he discovered that it was burning. When I am on the subject I may say that it is not the duty of a neighbor in the basement of this kind where two basements are contiguous, if you notice something wrong—if one neigh-

bor notices something wrong on the other neighbor's side, it is not his duty and it is not his right to go over there and interfere with the way he runs his furnace. He would be a trespasser to go in there and readjust or shut the door on the furnace or open the draft. It is his business to stay out of there when there is no danger pending. There is no duty on him when he sees that a man leaves his furnace door open and that is the way he operates his furnace usually, there is no duty on him to interfere with it, because one man cannot interfere with another's premises; he is a trespasser when he goes over there and does do something, if he does so. But if a neighbor saw a fire started in the basement outside in the rubbish and it was in that incipient stage where when he saw it by giving it reasonable attention he could have extinguished the fire and thereby prevented the fire from gaining headway and thereby saved his own goods from destruction, of course he is bound to use reasonable care and caution, just that care that the ordinarily careful and prudent person would use in protecting his own property by extinguishing a fire which he saw would do him injury, if he didn't do so or take some other means of doing so such as calling for help. But if, on the other hand, when a person discovers a fire which is under such headway that he cannot stop it and by attempting to stop the fire he would be in danger of being asphyxiated from excessive smoke or be in danger of being caught in the fire and forfeiting his life, be in danger in some way, why, there is no obligation that he should do anything except to save his own life at the earliest possible moment, and the easiest way of getting out of there.

This action is brought by the plaintiff to recover the value of a stock of merchandise and fixtures, together with a quantity of household furniture and certain tools which were destroyed by the fire on the 15th of April, 1924, as well as loss of profits during the time that the plaintiff was out of business. The plaintiff claims that the fire was caused by the negligence of defendant Heuvelhorst, who was the agent of defendant Thomas. The burden of proof is upon the plaintiff to establish by a preponderance of the evidence the essential allegations of negligence set forth in plaintiff's declaration, and unless you find that the plaintiff has established the essential elements and allegations of his declaration by a preponderance of the evidence the plaintiff cannot recover and your verdict will be for the defendant. . . .

The existence of negligence is an affirmative fact to be established by the plaintiff who alleges it as the foundation of his right to recover, and the burden is upon the plaintiff to point out by evidence which preponderates in his favor the defendant's fault which caused the injury.

Until the contrary is shown by a preponderance of the evidence, the presumption is that every man has not been negligent but has performed his duty.

The law will not allow negligence to be presumed without some proof of actual negligence. All speculation as to the antecedent probabilities must yield to the facts. Negligence cannot be presumed but must be affirmatively proved. Proof of the mere fact that that fire occurred without more, will not amount to a prima facie proof of negligence on the part of the defendants or either of them. The burden is on the plaintiff to show by competent evidence some act of negligence that was the proximate cause of the fire complained of. And when I say proximate cause of the fire, I mean the producing cause of the fire. If a witness or a party has testified falsely in any particular in this case on any essential element of the case or material fact in the case, you are at liberty to reject and disbelieve all the testimony of such witness. You are not bound to do so if it is corroborated by other credible evidence.

Cities' Legal Power to Prevent Fires.

The courts generally regard the prevention of fires in incorporated towns and cities as a matter for local regulation. It belongs to the ordinary police powers of the city, and, so far as consistent with state legislation, a general grant of police powers to pass ordinances for the welfare of the city includes authority to adopt and enforce reasonable fire regulations. (Cook County vs. Chicago, 142 Northeastern Reporter, 442, decided by the Illinois Supreme Court.)

In the cited case it was decided that a county erecting buildings within the city limits was amenable to municipal fire regulations. The Court said:

"The powers granted to counties under the general law do not include the police power. That power is granted to cities and villages under the act concerning their incorporation, and by that statute it extends to all buildings within its limits. The county is not required to build a court-house within the limits of any city, but may build it elsewhere if directed so to do by the people. . . . When the county builds a courthouse within the limits of a city, it may be held that in so doing it acts voluntarily. No good reason, therefore, is perceived why it should not be made amenable to the reasonable police regulations imposed by the city in the interest of the general welfare."

There are other decisions, however, to the effect that municipal fire regulations do not apply to public buildings of other governmental jurisdictions, where there is legislative intimation of intent to withhold from the municipality control over such buildings. (See 31 American Law Reports, 450.)

But, although a city, under its general police power, may adopt reasonable fire prevention ordinances, an ordinance which controls or regulates a common and useful private business or occupation is subject to review in the courts, for a test whether, under the guise of police regulation, there is an unwarranted interference with the constitutional rights of private citizens to pursue lawful occupations. (Harrigan & Reid Company vs. Burton, 195 Northwestern Reporter, 60.)

In the last cited case, the Michigan Supreme Court decided that an ordinance of the city of Detroit, purporting to regulate the installation of heating apparatus in private dwellings, was invalid because requiring heating contractors to give bonds to protect their patrons, and because vesting arbitrary power in licensing authorities. The Court added:

Reprinted from the department of *The American City*, conducted by A. L. H. Street, attorney-at-law.

"Another questionable feature of the ordinance, as a measure of fire protection, exercised under the police power, is that the restrictions and burdens it imposes are directed only against 'dwellings,' limited further by especially excepting hotels, club-houses, hospitals, jails, reformatories, and asylums, and also leaves untouched all other kinds of buildings in which heating systems or apparatus of some kind are necessarily installed and used, such as stores, office buildings, restaurants, banks, churches, station houses, factories, shops, etc. If fire protection was the purpose, an ordinance which only imposes the safeguarding regulations on dwellings and leaves free to ignore them all other buildings in the city, wherever located, which with their heating systems are likewise subject to the danger sought to be guarded against, savors strongly of discriminating and unreasonable class legislation."

The courts are not agreed as to the right of a city to station firemen, or other employees, in a theater at the expense of the operator of the theater. Such an ordinance adopted by the city of Mobile was upheld in the case of Tannenbaum vs. Rehm, 44 Southern Reporter, 532, the Alabama Supreme Court saying:

"The duty of protecting the person or citizen from dangers of fire in the exercise of the police power would seem to carry with it the right to employ the most effective means to that end, and this would include the right of designating competent agents or servants for the performance of such duty."

Citing decisions of the Louisiana Supreme Court and of the Maryland Court of Appeals, to the same effect, the Alabama court adds that a municipality may impose the cost of such service upon the manager of the theater, but that "of course such cost or expense must be fair and reasonable."

A similar conclusion was reached by the Connecticut Supreme Court of Errors in the case of Hartford vs. Parsons, 87 Atlantic Reporter, 1182.

However, in the case of Chicago vs. Weber, 92 Northeastern Reporter, 859, the Illinois Supreme Court took the opposite view, remarking:

"In every building in the city where large numbers of people are employed, or where the public go in crowds, the safety of those in the building would be promoted by having a member of the fire department there, and if the cost of discharging the duty to the public who attend theaters may be charged to the owner, the same requirement may be made of the owner of every other building where the public are invited or attend in numbers. The city has power to establish a fire department, to erect engine houses and provide fire engines and other implements for the prevention and extinguishment of fires, but that duty is a duty to the public. If there is power to charge the expenses of performing that public duty to the owner of a theater, there is also power to do the same thing with respect to other owners, and the members of the fire department could be parceled out and stationed in private buildings, so that practically the whole expense of the fire department would be paid by individuals or corporations. If the city has authority to do that, it could accomplish the same result with policemen, who are in the direct exercise of the police power, and they might be stationed in every building where disorder or violation of the law might occur, and the expense be charged to the owner. That the city cannot perform its duties to the public in that manner is manifest."

A similar conclusion was reached by the Arkansas Supreme Court in the case of Water vs. Leech, 3 Arkansas Supreme Court Reports, 110, decided in 1840.

An ordinance making the storage, etc., of rags dependent upon the unrestrained will of a chief of police was held by the Massachusetts Supreme Judicial Court to be void, in the case of Commonwealth vs. Maletsky, 89 Northeastern Reporter, 245. So, too, an ordinance requiring a special permit for storing boxes, etc., was held by the Minnesota Supreme Court to be invalid as ignoring the quantity, place or manner in which such material might be kept.

But the Indiana Supreme Court sustained the validity of an ordinance forbidding storing more than five tons of straw on one block, unless within a fire-resistive structure.

As to more common regulations, a standard legal authority notes:

"The enactment of ordinances establishing fire limits, and forbidding the use of inflammable materials in buildings or in the erection thereof within such limits have been uniformly sustained as proper methods of its exercise. While some courts hold that this power is inherent in a municipality, it nevertheless usually exists only by reason of an express grant or a necessarily implied statutory or constitutional delegation. Such ordinances cannot be retroactive and require the removal of existing buildings from the fire limits, but may prevent removal of forbidden structures into or even within such limits from one lot to another, and may authorize the summary demolition of buildings erected in violation of law. That a wooden structure ceases to be such when encased with iron has been held by some courts, but this view has not been generally accepted." 28 Cyc. 741-743.

Silk and Rayon.

By Wm. D. Grier.*

(Member N.F.P.A.)

The sensational growth of the artificial silk or rayon industry in the United States during the past few years would appear to make the subject a timely one for consideration by those interested in fire protection and insurance of manufacturing plants engaged in the industry.

While no special originality for these notes is claimed, it is but fair to say that with the exception of that portion relating to the natural silk industry as carried on in southern Europe and the far East, they are entirely the result of personal investigation extending over a term of years.

Those portions of the article of a purely chemical or technical nature are included for the benefit of such of our readers as may be interested in this aspect.

Natural Silk.

The fact that a useful textile fibre could be prepared from the cocoons of a kind of moth, seems to have been known to the Chinese at a very early period, 2640 B.C. The secret was carefully guarded for many centuries, it is said under pain of death, but it appears, or so the legend says, that several thousand years later two wandering Christian missionaries obtained some of the eggs, which they transported in a hollow bamboo cane to Constantinople, which at that time, the sixth century, was the capital of the Byzantine Empire. The value of the information was at once recognized by the Emperor Justinian, and the industry was established on a firm basis. From Constantinople the knowledge spread to Italy and France, which have always been, together with Japan and China, the headquarters of the silk industry, at least as far as the preparation of the raw silk is concerned.

The silk fibre is the product of the caterpillar or larva of a small white moth, scientifically known as "Bombyx mori." After the eggs are laid by the adult moth and the caterpillars hatched out, they are at once placed upon fresh mulberry leaves to feed. After increasing enormously in size and undergoing about seven molts or castings of the skin the caterpillars begin to show a sort of lassitude or disinclination to eat or move about, which is an indication that they are ready to spin.

The silk fibre is formed by a gelatinous or glutinous liquid secreted by the caterpillar and extruded from the openings of two small glands near the mouth. The caterpillar weaves around itself a cocoon or casing of silk thread, in which to undergo its transformation into the pupa stage and later into the perfect insect or moth. After the cocoons are finished,

*General Agent, North British & Mercantile Insurance Company, Ltd.

The illustrations to this article are prepared from original photographs by the author.

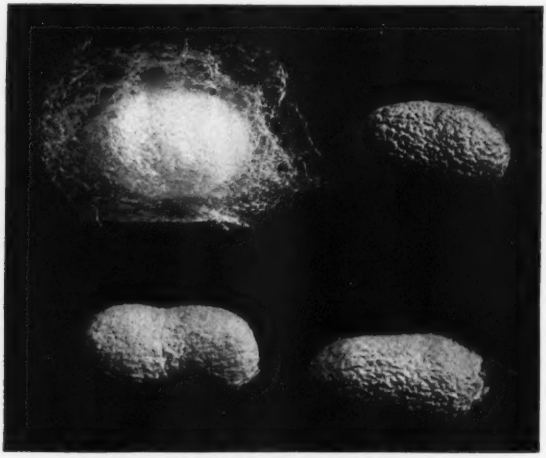
The silkworm moth, enlarged to about twice actual size.

which takes about five days, the pupa within is killed by steaming the cocoon, as, if allowed to mature, it would perforate the end, thus cutting the fibre and rendering the cocoon of minor value for the manufacture of silk.

The cocoons are sorted as to color, size, etc., the damaged or perforated cocoons being baled up separately for the manufacture of spun or floss silk. The perfect cocoons are immersed in hot water for the purpose of softening the silk glue or gum which holds the cocoons together. The cocoons are then transferred to water at 140 to 150° F., in which they float, enabling an expert operator to catch the end of the main filament with an implement somewhat resembling a whisk broom. If the water is too cold the gum does not soften; if it is too hot the cocoons collapse. The filaments from several cocoons, usually from five to twenty, are combined in such a way as to make a firm and well-rounded filament which is held together by the adhesion of the sticky fibres.

The filaments in the cocoon really consist of two distinct fibres, or "brins," as they are technically known, there being two glands from which the caterpillar spins. As the fibres are drawn off from the cocoons and combined, as previously stated, they are reeled off and made up into skeins, in which condition they are shipped and arrive in this country as the ordinary raw silk of commerce, so that each strand of raw silk really consists of anywhere from five to twenty single filaments united by the dry silk glue, giving the strand of raw silk a rough or harsh feeling. The rough, bark-like appearance under the microscope is caused by the dried and wrinkled silk glue.

The treatment of the cocoons and reeling off the silk is carried on in establishments known as "filatures," the work being done mostly by women working for very small wages. One cocoon yields from 500 to 1200 meters (1 meter = 39.37 in.) of silk consisting of two filaments or brins united in a single strand as described, which is technically known as a "bave" of approximately two and one-half "deniers". It is said that one ounce of eggs will produce 100 pounds of cocoons and that 12 to 14 pounds of cocoons equal one pound of pure silk. The single filaments vary somewhat in size, averaging around 15-20 thousandths of a milli-



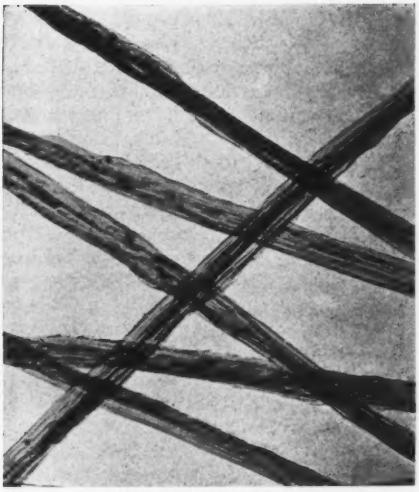
Cocoons of silk worm, actual size.

meter (1 millimeter = .039 in.) in size. They are more or less cylindrical and smooth, occasionally exhibiting some marks or irregularities when examined under the microscope.

The silk fibre consists of a substance known chemically as "fibroin," very much the same in its nature as hair, horn, feathers, etc. The silk gum or glue alluded to consists of a substance known as "sericin." The gum or sericin is soluble in boiling water or hot soap suds; the fibroin or silk filament proper is insoluble in water but may be dissolved in caustic alkalies very readily. This property of solubility in caustic alkalies is one way in which the natural silk can be readily distinguished from the various kinds of rayon or artificial silk.

Upon receipt of the raw silk in the warehouse, it is graded and classified, being stored under conditions which tend to maintain a certain amount of moisture, as when thoroughly dry the raw silk is rather harsh and brittle. The raw silk is very hygroscopic, taking up moisture from the atmosphere. It is sold by weight, and in sampling is dried four hours at 230° F. and weighed, 11% being allowed as a trade custom for a normal absorption of water, or regain.

From the warehouse the silk generally goes direct to a silk throwing establishment (from throw, to whirl or spin), which is somewhat analogous to a spinning mill in other textile industries, although the processes are quite different. Before the silk can be thrown or reeled, it is necessary that it be "boiled off" in a mixture of soap and water in order to dissolve the sericin or silk glue. One formula for the boiling off recommends the use of sixty pounds of soap to two hundred gallons of water for every three hundred pounds of silk. The silk is worked in a bath on rods at 195° F. to remove the sericin and loses from 20% to 27% in weight. The boiled off liquid is preserved, being used at a later stage in dyeing and finishing silk.



Raw silk as received at silk throwing plant. About 16 strands stuck together by silk gum. Magnified about 100 times.

After drying, the hanks of raw silk are placed on reels called "swifts," from which the silk is wound off on bobbins. The bobbins are then removed to the first spinning frames and several fibres twisted into one. The silk is then cleaned by reeling from one bobbin to another passing through a device for stopping lumps. It then goes to the doubling room where twenty or more strands are wound in one bobbin. Bobbins to the number of strands which are being twisted on one thread are mounted on a large upright frame known as a "creel," passing through "fallers," which automatically stop the machine if the thread breaks, to the final assemblage or twist, from which it is reeled off on spindles or flyers, from which it is hanked or reeled up for the market.

This, in a very general way, covers the production of silk from the moth to the finished silk thread ready to be made into broad silk, ribbon, sewing silk, crochet silk, etc. There are several varieties of raw silk, depending largely upon the district where prepared, varying in color from a white to a deep yellow. The color seems to be due largely to the silk gum as it disappears on boiling off.

There are some other species of silk moth which will not breed in captivity. The cocoons are known as "wild cocoons" and are gathered by natives. This variety of silk is a brownish yellow in color, generally known as tussah silk, from which the woven fabric known as pongee is prepared. In this case the thread or yarn, known as singles, is made from single strand of raw silk made from the filaments of eight or ten cocoons, not doubled or twisted very much. Tussah or wild silk is said to be much stronger than ordinary silk and the fibre is six or seven times larger.

One peculiar property of silk is in its ability to take up considerable quantity of metallic compounds, for example tin chloride, and this peculiarity is made use of in silk manufacturing for the purpose of weighting the silk and increasing the diameter of the thread.

There have been attempts made to utilize the cocoons of other moths in the preparation of silks, but without very much success. Some years ago an attempt was made in this country to utilize the cocoons of the "Samia cecropia," sometimes called the American silk worm, but the attempt was not successful. The cultivation of the moths, eggs and caterpillars calls for a great deal of experience and knowledge as well as favorable climatic conditions.

An explanation of some of the terms used frequently in alluding to silk and its uses may not be out of place. Silk used for warp threads is usually known as organzine, two or three twisted strands spun in a direction contrary to that from which they are separately twisted. The weft thread or filler is known as trams. This consists of two or three strands, not twisted before doubling, and only lightly spun. The term "souples" is sometimes applied to silk which is not entirely boiled off and is used in the manufacture of some fabrics such as bolting cloth.

The term "denier" is frequently met with in silk literature. This is a unit of weight, and by general agreement in the trade, a strand of silk 450 meters long, of the weight of five centigrams, equals one denier. The denier is a unit of weight rather than size. This unit is used in the same way as various counts of cotton thread. Sizing is done under controlled conditions of humidity and is measured by means of a standard reel that stops automatically at 450 meters. The same term is used in connection with artificial silk or rayon.

As with all the highly cultivated or intensively bred animals and plants, the silk caterpillars are subject to various diseases. One of these, which is known as "muscardine," threatened at one time to annihilate the silk industry of France, but the great scientist Pasteur made a thorough investigation of this, finding it to be a fungus, scientifically known as "Botrytis bassonia," which affected the caterpillars, particularly the weak or sickly ones, and suggested remedies and preventives which were found to be most efficacious.

Artificial Silk.

As may readily be imagined, the attention of scientists and inventors has been turned for many years to the production of some sort of fibre which would have the same properties as natural or silk worm silk and a great deal of time and thought has been given to this matter.

Early in the eighteenth century Reaumur suggested that natural silk might be imitated by some artificial means and at one time an attempt was made to use gelatin for the purpose, coagulating it with formalin, potassium bichromate or some compound having similar properties, but as far as the writer has been able to learn, gelatin silk never was commercially successful.

In the early nineties Cross and Bevan, in the course of their researches on cellulose, patented a process for making threads or filaments

from a viscous compound known as viscose. In 1884 Count de Chardonnet invented a process for making filaments or threads from collodion and in 1890 Despeissis patented a process for making filaments from cotton cellulose dissolved in an ammoniacal solution of copper hydroxide. The cellulose acetate process was developed at a later period. These are probably the principal landmarks in the history of artificial or synthetic textile fibres.

In all of these processes the fundamental principle is followed of preparing a viscous fluid analogous to the secretion of the silk worm, forcing this under high pressure, through minute orifices from .002 to .005 inch in diameter, which imitate the spinnerets of the silk worm or the spider, and coagulating by a chemical solution which again parallels the secretion manufactured by the silk worm for the same purposes. These filaments then receive further appropriate treatments and are reeled off or thrown, much as natural silk is. They may be divided into two classes, one in which the fibre when finished reverts practically to its original state of cellulose and the other in which it is not cellulose but an entirely different compound. The first class is typified by viscose and the second by acetate silk.

At the present time the subject of artificial silk or rayon is attracting widespread attention. It has practically ceased to become a substitute for natural silk, and is entitled to be ranked as a fifth textile fibre, which has been given to mankind as a result of chemical research. The term "rayon" has been agreed upon as the trade name for all of the varieties and officially accepted by the U. S. Federal Trade Commission.

Few of us are aware of the immense amounts of this material which are being manufactured and sold, and it is of interest to note that very large quantities are made abroad by the great English concerns of Courtaulds, Ltd., which works on the viscose process, the British Celanese, Ltd., making acetate silk, while in Belgium the Tubize Company manufactures an enormous quantity of Chardonnet silk. There are also large concerns in Germany making cuprammonium or Pauly silk and viscose silks, while a large concern in Italy is endeavoring to market its product, viscose in the shape of rayon, artificial cotton, artificial wool and artificial horsehair, in the United States.

In the United States there are a number of very large and up-to-date plants manufacturing enormous quantities of rayon. It is stated that rayon has now attained the rank of third place in the production of the textiles of the world, exceeded only by cotton and wool. It is said that in the United States 39,400,000 pounds of rayon were produced in the year 1923, and that in 1924 the world production was over 100,000,000 pounds.

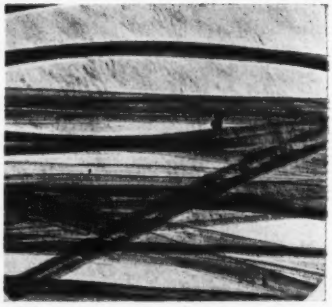
Natural silk loses about 20 per cent of its strength when wet, while rayon will lose ordinarily about 25 to 65 per cent, depending upon the type of rayon being tested. For a given weight of thread rayon has from one-half to three-quarters of the strength of natural silk and possesses the ability to stretch 15 to 20 per cent before breaking; while natural silk stretches about 22 per cent before breaking.

The uses of rayon are many and need not be detailed in this article. Some varieties may be chemically treated for the purpose of crinkling

and delustering them, giving the effect of wool, hair, etc. It is said that ammonium sulpho-cyanide may be used for this.

Due to the fact that the several varieties of rayon have different properties as far as dyeing is concerned, it is possible to make up fabrics of different kinds of rayon, which are dyed different colors by cross dyeing in one bath, and the possibilities in this line are said to be very great.

The cost of rayon today is from $1.75 to $3.50 a pound as compared with natural silk at from $5.50 to $7.50 a pound, and wild silk at about $3.00 a pound.



Viscose rayon, showing characteristic striations. Magnified about 100 times.

The basic raw material for the several types of textile fibres going under the collective name of rayon is cellulose in the form of wood pulp or raw cotton. The term cellulose is applied to the material, either pure or somewhat modified, which forms the basis of practically all vegetable tissue. In the form of raw cotton or highest grade of bleached wood pulp it is obtainable in a very pure condition. The raw cotton used is generally of the grade known as linters, being the short hairs removed from the cotton seed in the process of reginning, the fibre of which is too short to be of value for spinning. The wood pulp used is of a high grade prepared by the usual processes of sawing up spruce logs into suitable lengths, removing the bark, cutting the wood up into fine chips which are subjected for several hours to the action of a solution of sulphite of lime, at a high temperature and pressure, bleaching and thoroughly washing in the same manner as in the preparation of paper stock from wood pulp.

The Viscose Process.

Practically all of the concerns manufacturing viscose silk use about the same processes, subject to some private variations of their own. The process, generally speaking, consists of treating a very high grade bleached wood pulp (although cotton linters may be used) with a solution of caustic soda. After the proper time has elapsed the excess soda is squeezed out and the pulp placed in shredders which break it up, it being necessary to keep the temperature down by artificial means, as the heat of reaction is about 68° F. After shredding the pulp is allowed to ripen for a certain period at a temperature of about 70° F. It is then treated with carbon disulphide in churns or mixers where it is converted into a substance known as cellulose xanthate. This receives further treatment with water and caustic soda where it is kept cool and after thorough mixture and agitation it is then in the shape of a viscous liquid, allowed to ripen and settle, it being very necessary that all trace of foreign material or unconverted fibres be removed before any attempt is made to spin it into thread. When it has reached the proper condition it is forced through

minute orifices into a bath of dilute sulphuric acid, the fibres being spun from the hardening solution on glass spools.

Incidentally a substance known as cellophane is prepared from a viscose solution by extruding it through a very narrow slit from which it emerges in very thin transparent sheets which are used for wrapping confectionery, pastry and the like.

Viscose occurs in colorless glassy fibres deeply scored with longitudinal grooves, of irregular cross section. The fibres vary considerably in diameter from 0.035 to 0.050 mm. in samples measured by the writer. The fibres exhibit a brilliant play of colors when examined by polarized light and the transparent colorless film known as cellophane is said to be transparent to ultra violet rays. Various chemical tests are described for distinguishing viscose from other textile fibres but they are hardly needed as the appearance of the fibres under even a comparatively weak magnification is highly characteristic.

Cellulose Acetate Silk.

In the cellulose acetate process, cleaned, bleached cotton linters are treated with a mixture of acetic anhydrid, acetic acid and a little sulphuric acid in churns kept cool by refrigeration, where the mass is kneaded and worked for several hours. The contents are then removed and allowed to ripen for several hours, during which time the reaction takes place. The solution is then conveyed to tanks where water is added and the whole allowed to stand quiet when the cellulose acetate is precipitated as a solid.

The contents are then dumped to centrifuges which separate the solid cellulose acetate from the liquid, which consists of acetic acid. The acetate is then thoroughly washed, centrifuged and pulverized to a white, flaky mass. After this it is dried. In this condition it will not burn but a flame causes it to break down or melt in small globules.

The cellulose acetate is then dissolved in acetone and after thorough filtration through cotton batting is squirted through minute holes in small metal discs. The threads dry and solidify as soon as they reach the air and are reeled off as they emerge from the die, the solvent being recovered. It must be borne in mind that the cellulose acetate silks are quite different from the viscose or so-called regenerated fibres, the latter having been treated with coagulating solution or in the case of nitro silks denitrated, washed, bleached and dried, revert practically to their original condition of cellulose, whereas the acetate celluloses remain quite different from their original condition as evinced by the fact that acetate cellulose thread may be dissolved in appropriate solvents.

There are two varieties of acetate silks made in the United States, one known as Lustron and the other called Celanese. These occur in colorless glassy filaments, Lustron averaging about 0.045 mm. in diameter and Celanese about 0.020 mm. in diameter, showing numerous inclusions and specks in some samples, especially under high magnification. Some varieties show a great many roughnesses on the fibre under high magnification. Some samples are said to show very fine striations, which are very difficult to see even with high magnification.

The acetate silks are rapidly attacked by chloroform. The Lustron seems to dissolve very rapidly, while the Celanese sinks into a colorless jelly. A quick test may be made by holding a few fibres near a lighted match when the flame of the burning fibre will be seen to be preceded by a small black globule of melted material. This seems to be quite characteristic. Under polarized light the fibres of Lustron seem to be uniformly of steel-blue tone, polarizing rather feebly, while the Celanese is somewhat more brilliant, but neither of them polarize as brilliantly as silk and the other textile fibres.

Nitro Silks.

Nitro silks are made practically by the original Chardonnet process, cleaned and bleached cotton linters being nitrated in the usual manner with mixed acid, the product thoroughly washed, dehydrated and dissolved in a mixture of ether and alcohol.

After settling and filtering the solution is squirted through glass nozzles or jets of minute size into a bath of weak sulphuric acid from which it is spun wet on to glass spools, removed to a denitrating bath of alkali, washed, bleached and dried.

Tubize or nitro silk occurs in transparent filaments somewhat resembling the acetate silk under the microscope, but it can be immediately differentiated from an acetate cellulose by the fact that the fibres polarize brilliantly and are not soluble in chloroform. Fibres examined by the writer seem to run about 0.040 mm. in diameter.

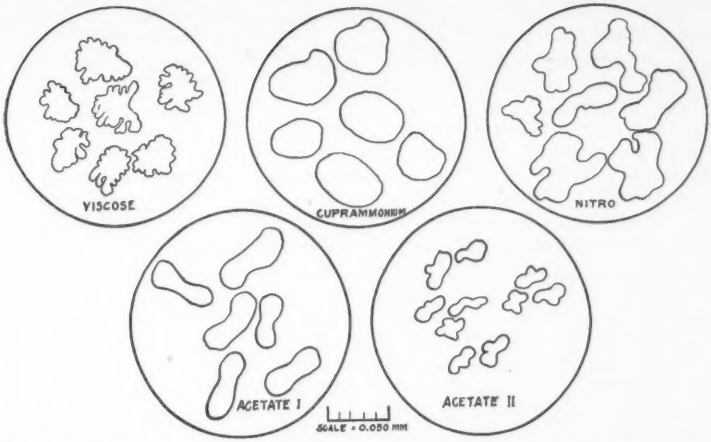
It is interesting to note that early in the history of the Chardonnet or nitro silks it was proposed to manufacture fibres of different colors by mixing coal tar dyes directly with the collodion, but for some reason or other this process never seemed to be very successful, probably on account of the necessity for denitrification. The denitrating process colors the fibres yellow and they require bleaching by the ordinary methods. This is probably particularly the case when ammonium sulphide containing polysulphides in solution is used in the denitration process. The Chardonnet silks dye very easily.

Various modifications of the process have been proposed from time to time, but as far as the writer has been able to observe the original process is followed quite closely, making proper allowance for refinements or improvements that have been worked out.

Cuprammonium Silk.

The fourth variety of rayon, known as the cuprammonium, generally known in Germany as "glanzstoff" or "Pauly" silk, is not made in the United States in any commercial quantities as far as the writer has been able to discover, although there is probably some of the material on the market. It is stated that some large manufacturers of this material are to erect a plant in this country. Essentially the manufacture of this fibre depends upon the fact that cellulose is soluble in an alkaline solution of copper oxide. The solvent is practically the same as the solution generally known as Schweitzer's reagent, and this is made in various ways, either by acting upon copper turnings with ammonia through which air is blown or by preparing the copper oxide separately and dissolving it in ammonia.

This property of cellulose may be experimentally demonstrated by adding ammonia to a strong solution of copper sulphate until the precipi-



Cross sections of rayon fibres. Highly magnified. From original drawings.

tate which forms is redissolved. This solution will be found to dissolve cotton fibre very rapidly. The proper preparation of the solvent seems to be a very difficult operation and one where a great deal of expert knowledge and experience is required. After solution and clarification of the cotton, the threads are formed by forcing the solution under high pressure through orifices in platinum jets or dies into a coagulating solution of sulphuric or hydrochloric acid or a 30% caustic soda bath. The filaments are wound directly on bobbins as in the other processes which are placed on wash racks where they are very thoroughly washed, after which they are dried. It is said that this variety of rayon is very remarkable in its behavior with dyes, being able to take the most delicate shades without difficulty. There is no reason to doubt, however, that its preparation is attended with many difficulties and requires a great deal of very expert knowledge and experience practically in every stage.

Hazards of Manufacturing.

There is practically no special hazard in the process of silk throwing, the only hazards involved being those inseparable from any factory where machinery is used and labor employed. As a general proposition a large number of the silk throwing establishments in the United States are of slow burning or fire-resistive construction and equipped with automatic sprinklers.

The only special feature is in the storage of the raw silk. This, running as it does from $7.00 to $10.00 a pound in value, leads to the concentration of considerable value in a comparatively small space. The storage vaults should be, and usually are, of fire-resistive construction, so arranged as to minimize the chances of damage from fire, smoke or water. The great value of the raw stock and the necessity for securing it against theft or pilferage usually means that it will be kept in a secure and safe location in the mill.

The hazards of the manufacture of rayon or artificial silk vary somewhat according to the nature of the process. In the manufacture of viscose the principal and in fact only hazard of any note is in the use of carbon disulphide in the treatment of the stock after it has been subjected to the action of caustic soda. Carbon disulphide is an exceedingly flammable liquid of high volatility and a very offensive odor. The vapor is very explosive mixed with air. The liquid itself can be ignited by contact with a hot steam pipe, and, taking it altogether, it is probably the most hazardous liquid used in manufacturing processes at present. In practically all of the viscose factories in the United States the carbon disulphide treatment is carried out in comparatively small buildings of slow burning or fire-resistive construction located at a considerable distance from the main plant, and, generally speaking, the percentage of value of the property as a whole in the carbon disulphide building is very small. The carbon disulphide itself should be and usually is stored in outside tanks which are submerged in water, the liquid being pumped or forced to the mixing tanks in such a way that there can be no gravity flow.

In some plants there is a slight hazard in the drying of the finished stock, but this is probably not as great as that in an ordinary spinning mill.

Cuprammonium silk is not being made on a commercial basis at present in the United States as far as the writer is aware, but there is no reason to suppose that the hazard would be very serious excepting that probably some cotton picking or carding hazards may be developed in the preparation of the stock prior to making up the solution.

In the manufacture of acetate silks the hazards are somewhat greater than in the case of the viscose or cuprammonium process. The process usually involves the cleaning, drying and preparation of raw cotton, the hazards of which are well known and easily controlled, the subjecting of the cotton to the action of acetic anhydrid and sulphuric acid with the recovery of acetic acid involving only a moderate hazard. Practically the only serious hazard in the manufacture of acetate silk is in preparing the solution of cellulose acetate in acetone or similar volatile and flammable solvents, together with the recovery of the solvent from the filaments as they are spun and dried.

While these processes involve more or less of a flammable vapor hazard, they are usually carried on in a tight system of piping and in such a way as to minimize the hazard to a remarkable extent.

The manufacture of Chardonnet or nitro silk probably involves more hazard than the other processes. The first hazard, the cleaning, dyeing and preparation of the cotton linter base, involves well known and easily controllable hazards. The nitration of the cotton involves rather a serious hazard, but one which can be and usually is well arranged. The subsequent washing and beating of the nitro cotton is not especially hazardous. The dehydration and solution of the nitrated cotton in a mixture of alcohol and ether is essentially a serious hazard, but as usually carried on in the United States the hazard is reduced to a minimum.

The nitrated cotton filaments are spun wet prior to de-nitration. This involves more or less waste and strippings from the spinning frames, but

it is customary to gather these up at frequent intervals, and as soon as a pound or so has accumulated at each frame, it is immediately removed and destroyed.

As a matter of fact, reduced to its lowest terms, the hazards involved in the manufacture of rayon or artificial silk are practically limited to the use of certain volatile and flammable liquids at one stage in the process. At the present time the industry in this country is in the hands of a few very large and prosperous concerns which manufacture their goods in plants especially constructed for the purpose, of the highest type of slow burning or fire-resistive construction so arranged as to segregate the severest hazards in such a way that only a very small percentage loss could be suffered even by the total destruction of the more hazardous portions.

Owing to the fact that it is practically impossible to manufacture artificial silk on a profitable basis without the investment of a very large sum in the plant before a single pound is manufactured, it is very unlikely that any of the actual manufacturing of this material will be found outside of plants especially designed and constructed for the purpose and operated by concerns of large resources. As far as the finished fibre is concerned, it is rapidly coming into use in textile mills either alone or in a mixture with other textile fibres.

Recently many questions have been asked by manufacturers desirous of using this material as to the hazards involved in spinning or weaving it. Exhaustive tests have shown that the hazard is no greater than that involved in the handling of cotton and it is doubtful if even as much hazard will be found owing to the fact that there will probably be little or no lint or fly, in the use of the material. In itself it is no more flammable than cotton.

As far as the nitro silk is concerned, this ceases to be nitro cotton after it has been through the de-nitrating bath, being in the class of so-called regenerated artificial silks, which when finished revert to their original chemical condition of cellulose. It is not improbable that a lesser degree of salvage on stocks of rayon goods that have been damaged by fire, smoke or water may be expected than in the case of cotton or other textile fibres, although as yet there is little or no experience on this point as far as the writer is aware.

In conclusion, the invention of rayon, or artificial silk, is one of the greatest triumphs of modern chemistry. It is not a thing that was stumbled on or originated in a haphazard manner, but is the product of some of the finest and most highly trained chemists the world has ever known, working along definite lines with a specific purpose in view; namely, to produce from cellulose continuous fibres of sufficient strength, durability and elasticity to be woven into fabrics and capable of being dyed or otherwise treated.

Lafayette Hotel Fire, Allentown, Pa.

By E. S. Chapin.
(Member N.F.P.A.)

Thirteen people lost their lives and five were seriously injured when fire broke out about 2:30 A. M., Saturday, January 23, 1926, on the fourth floor of the Lafayette Hotel, 133-37 North Seventh Street, Allentown, Pa.

The building was erected in 1809 and was originally three stories in height, but was remodelled in 1890 by the addition of two more stories and a rear four-story addition, separated from the main five-story part by a three-story wing. When the two additional floors were added, the old tin roof was left in place; this helped to check the downward spread of the fire. The older portion was of stone and the additions were brick.

Means of egress consisted of an open stairway at the center of the main section, another in the four story rear section, an open elevator adjacent to the main stairway, a fire escape of the usual open iron type with counter-balanced bottom swinging section on the south end of the main building and another on the rear of the four-story section.

For years this hotel was frequented by farmers bringing produce to market, and a stable in the rear provided nest material such as hay, straw, feathers, horsehair, etc., for hundreds of sparrows which lived in the roof and walls of the building. While it was heated from an external community steam heating plant, soft coal was being used for cooking purposes. It is thought that a defective flue caused this flammable stuff in the walls and old roof to ignite and that the flames feeding on more communicated through the upper walls and floors and had been burning for a considerable time before discovery. This would account for the fact that the two upper floors were so thoroughly involved from the first minute and that internal telephone and light wires were burned off. Other possible causes were crossed electric wiring, which might also have ignited the birds' nests, or smoking in bed by a drowsy lodger.

Most of the patrons were permanent guests who made this hotel their home. The night clerk was talking with one of the lodgers, a linotype operator on a local paper who had just come in from work, when they heard outcries above and noticed smoke. They attempted to arouse the 45 guests by using the house telephone switchboard, but could not get in touch with the two upper floors. The clerk started up in the elevator but was driven back when the car caught fire and he had hardly returned to the third floor when the supports holding the elevators burned away

Photograph by International.

Thirteen persons were killed and five seriously injured in the Lafayette Hotel fire, Allentown, Pa., January 23, 1926. The ladder truck shown in this picture did not arrive until half an hour after the alarm had been given.

and the car fell to the bottom of the shaft. Brands carried down with it caused the fire to start anew below the fourth floor.

Meanwhile an alarm had been turned in by a taxicab driver and the companies on duty responded. The ladder truck of the Rescue Company, driven by a man 63 years old weighing 265 pounds and with a man 65 years old at the tiller wheel, became stuck in the car tracks in front of the building when the front wheels were locked crosswise of the body. The only other ladder truck in the city, that of the Hibernia Company, was off night duty for that week. A telephone call to the Hibernias was not explicit and they responded with a hose wagon only. It was then necessary for one of the drivers to call his wife and have her arouse the driver and tillerman of the ladder truck which finally reached the fire thirty minutes later. This company removed eight lodgers who were hanging from front window ledges on the fourth and fifth floors. Two men jumped, one being killed and the other injured when his fall was broken by the body of the first. Nets were not available and would have been of little use as there was a one-story porch balcony all along the front of the building.

All accounts agree that the flames had gained such headway before they were discovered that the hallways on the fourth and fifth floors were impassable, so that the windows afforded the only means of escape. Smoke alone caused the death of five of the lodgers who were later found in their rooms unmarked by the flames. Only one man reached a fire escape, while a domestic lost her life within a few feet of it.

With the thermometer at 9° F. the firemen were greatly hampered by ice which formed on the sidewalk, hose, clothing, ladders and walls. Some lodgers reached safety by knotting bed clothes down which they slid to the balcony roof, whence they were removed by ladders, while others were brought out by hand ladders held at the bottom by firemen and volunteers who had to raise them on their hands in order to reach the upper floor windows.

One of the survivors told of knocking on another man's door, but the occupant called out that he was unable to rise, and the would-be rescuer was driven away by the flames before he could do anything to help, and was later removed from his own burning window ledge by firemen.

Whatever the cause, the spread of the flames was aided by flimsy interior wall construction, open stairways and the open elevator shaft. A good sprinkler system might have materially reduced the loss of life. One of the seriously injured was a representative of a well know sprinkler manufacturer.

The Allentown fire department is a volunteer organization consisting of thirteen companies, six being on duty during the day and seven at night. Each week they change shifts so that they alternate on day and night work. At night the only men at the quarters are those necessary to drive the apparatus and pipemen, other members being called and responding directly from their homes.

On the night of January 23rd the Pioneer Hose Company was holding its annual banquet and most of the members of the other companies were at that function when the fire broke out, going from there to the scene. Two companies, Pioneer and Franklin, were off duty with permission. All but these two were in service at this fire.

The building was a total loss, estimated at $200,000.

Outside Sprinklers Save Factory Building.

A fire that was fought beforehand.*

Victories are not won entirely on the day the battle is fought. Planning in advance, anticipating the emergency and preparing for it, are just as important as acting intelligently at the critical moment.

The Waterbury Clock Company is to be complimented on doing all of these things in protecting and defending themselves against the severe fire exposure of a row of wooden buildings less than ten feet away from one of their five-story buildings. The factory windows facing the exposure are about five feet wide and seven feet high, and a few years ago were equipped with wired glass in metal frames. Above the windows on the third and fifth stories was installed a row of outside sprinklers with half-inch outlets, which are less liable to obstruction than the smaller sizes often employed. The watchmen were instructed how to turn on these open sprinklers in case of fire.

Eighty bags of sawdust were kept ready in the building for preventing the spread of water over the floors in case the automatic sprinklers should open inside the building. The basement was amply drained, and the goods there were stored on skids so that water on the floor would not damage them. Advance preparations had been well made.

The fire came. At three o'clock on the morning of January 29, a passing policeman saw flames in one of the wooden buildings and gave the alarm. The fire department responded promptly, but not with the usual amount of apparatus at first, a part having been called to another fire which was in progress at the same time. This caused some delay in getting a sufficient number of hose streams into action quickly, with the result that the fire gained considerable headway.

The burning building, a three-story wooden bottling factory without sprinklers, contained several hundred gallons of alcohol, which intensified the fire. A gale of wind drove the heat and flame against the windows of the Waterbury Clock Company's building; but the watchman had turned on the outside sprinklers as soon as the danger was discovered, and the water playing on the wired glass windows prevented the fire from entering the building. The fire pump was started at the same time and supplied plenty of water at good pressure for the outside sprinklers.

---

* Reprinted from *Factory Mutual Record*, published by the Inspection Department of the Associated Factory Mutual Fire Insurance Cos. (Member N.F.P.A.).

So effective was this protection that no fire damage was done to the clock factory, except for the cracking of a few panes of glass, but not seriously enough to require replacing. Plain glass when exposed to fire is quickly cracked by the heat and falls out of place, leaving openings for the entrance of water and sparks. Wired glass alone without open sprinklers will crack and remain in place, but under prolonged exposure to severe fire will soften and sag out of the window frame. In addition, wired glass allows considerable heat to radiate into a building, and therefore should be supplemented by outside sprinklers when the fire exposure is severe. For conditions where open sprinklers are impractical, due to a limited water supply, tin-clad shutters give better protection, but they must be closed to be of value.

During this fire, water was driven into the building around the windows by the combined action of the outside sprinklers, the strong wind, and the hose streams of the fire department. The night-cleaning crew, under the direction of the superintendent, used brooms and sawdust to confine the water to a narrow strip next to the wall on all floors. The leakage into the basement was considerable, but did not damage the goods because of the floor drains and skids.

The heat which radiated through the water and the windows was so noticeable in the building that windows were opened on the side away from the fire to prevent the automatic sprinklers from opening within the building. The fire was extinguished by the public department in about five hours.

The damage to the Waterbury Clock Company's factory amounted to only $890, and was entirely by water. The loss might easily have been $100,000 had fire entered the windows, as the thousands of clock movements and other valuable stock would have been ruined by the opening of the inside sprinklers.

This fire furnishes a noteworthy example of special fire-protective equipment provided for a specific purpose and used with excellent judgment to prevent a large loss. It also shows the value of wired-glass windows and outside sprinklers supplied with water at good pressure for protecting against exposure fires.

The Chateau Frontenac Fire.

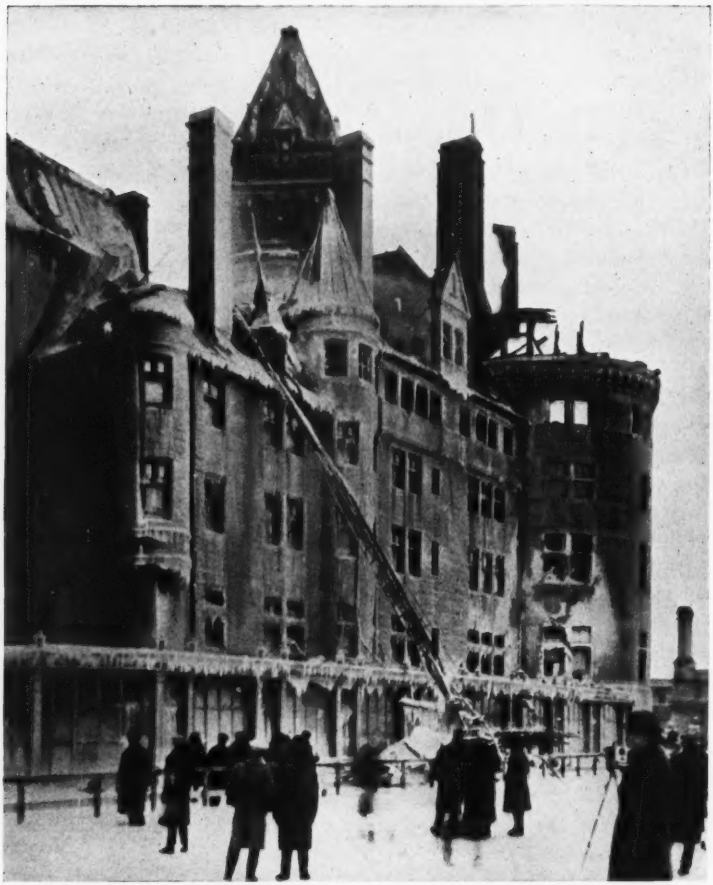
A section of the Chateau Frontenac Hotel, Quebec, was destroyed by fire on January 14, 1926, with a loss estimated at between $800,000 and $900,000. The fire was confined to the older section of the building which was of wooden interior construction, being kept out of the newer fire-resistive portions by rolling steel fire doors which performed their intended function with entire satisfaction.

The burned portion was from five and one-half to six and one-half stories in height with numerous cupolas and towers. The walls were brick, the floors of heavy joisted construction, the interior finish wooden lath and plaster. This part of the building was sub-divided by two fire walls. These, however, stopped short of the roof, and the fire, originating in the upper portion of the building, soon spread from the point of origin through the attic space over the tops of these walls. At the time of the fire the burned portion was not used, being closed for the winter season, all the guests being quartered in the newer fire-resistive portion.

The fire was discovered about 5:40 P. M. on January 14. The alarm was transmitted from a private box on the fourth floor to the hotel office. The city alarm was immediately given. This was followed by a general alarm at 6 P. M. It is said that it was some five hours before the fire was brought under control. The "all-out" signal was not given until nearly twenty-four hours after the start of the fire, 5:02 P. M. on January 15.

The exact origin of the fire has not been determined. It started in a room used for the storage of furniture on the fifth floor, spread up into the roof space and from there gradually burned downwards. The following is taken from the report of the Canadian Fire Underwriters' Association (Member N.F.P.A.) on this fire:

On arrival of the first apparatus considerable smoke was found on the second and third floors, but more particularly in the corridors on the fourth and fifth floors of the hotel. After investigation by the chief, which took about fifteen minutes, the fire was located in a room on the fifth floor used for the storage of furniture. Two lines of 2½-inch hose with 1-inch nozzles attached were immediately laid from a nearby standpipe and the streams directed into the room where the fire was located. With the roof, however, soon burned through and owing to open space between ceilings and roof and to the fact that dividing walls did not completely extend to the latter, the fire, fanned by a strong wind



Photograph by Underwood and Underwood.

View of the section of the Chateau Frontenac, Quebec, destroyed by fire on January 14.

(which according to records of the Quebec Observatory was blowing from the east at a velocity of twenty-eight miles per hour), spread with great rapidity. In the meantime, a total of ten lines of 2½-inch hose with 1-inch nozzles attached were laid from standpipes on third, fourth and fifth floors. For the supply of these lines, private electrically-driven fire pump of 1,000 gallons per minute capacity, located in the basement of the hotel and taking supplies from an 8-inch city main, maintained pressures varying from 140 to 160 pounds per square inch. To combat the fire from the outside of the building, an automobile pumper of 1,000

gallons capacity per minute worked at draft from underground tank located on the "Terrace." This tank, which has a capacity of 186,000 gallons, is supplied through a 6-inch pipe laid directly from a two-stage electrically-driven centrifugal pump of 350 gallons capacity, taking supplies from the St. Lawrence River and located in a small, frame, metal-clad pumphouse on the old Allan Line wharf. From this pumping engine four lines of hose, each 200 feet long and with 1-inch, 1¼-inch and 1½-inch nozzles, were taken up aerial ladders and the streams directed through windows on the fifth floor. A steam fire engine of 800 gallons capacity, coupled to a hydrant at the corner of St. Anne and Du Tresor Streets, supplied two streams through two lines of hose, each 600 feet long, with 1-inch nozzles attached. Another steam engine of 400 gallons capacity, coupled to a hydrant at Place d'Armes, supplied one stream through a line of hose 600 feet long with 1¼-inch nozzle attached. An automobile pumping engine of 350 gallons capacity, coupled to a hydrant at the corner of Des Carriers and Mont Carmel Streets, supplied one stream (through two lines of hose siamesed into one) with 1¼-inch nozzle attached. Engine pressures ranged from 125 to 200 pounds per square inch.

With fire doors between fire-resistive and non-fire-resistive sections functioning properly, the fire was confined to the latter sections. The most effective work pertaining to extinguishment was accomplished with the private water supply and other fire fighting facilities of the hotel in the hands of the Quebec Fire Department. Valuable service was also rendered by the department by suitably spreading a total of fifty-two waterproof covers.

Aid was summoned from Montreal and Three Rivers, Quebec, apparatus being dispatched on a special train leaving Montreal at 11 P. M. and arriving at Quebec at 4:15 A. M. on the following morning. It is reported that the Chief of the Quebec Fire Department was not informed of this until 1 A. M. The fire being under control when the apparatus arrived it was unnecessary to unload it from the special train.

This fire is of particular interest in demonstrating the value of effective cut-offs between sections of a large structure such as this and the important function of the private water supply system. The municipal protection water works system alone would have been inadequate to supply the water needed during this fire. The private reservoir and the pumps in the basement of the hotel which supplied a large volume of water having satisfactory pressure for ten hose streams from standpipes were instrumental in the extinguishment of the fire.

Fig. 1. The Equitable Building, New York, largest office building in the world. This "fireproof" building was damaged by fire on February 16, 1926, as described by the accompanying article.

The Second Equitable Building Fire.

Report by William B. White (Member N.F.P.A.).

New York Board of Fire Underwriters.

The fire in the Equitable Building, New York, occurring at 3:05 A. M. on February 16, 1926, for which four alarms were sounded, occasioned great interest on the part of the public as well as of the fire protection fraternity. The Equitable Building, the largest office building in the world, is of modern fire-resistive construction and few would have imagined that a fire of any magnitude was possible in a structure of this character.

This fire recalled vividly the spectacular fire of January 9, 1912, which destroyed the old office building of the Equitable Life Assurance Society at the same location. The fire of 1912 destroyed the building, which at that time was supposedly a "fireproof" structure and much concern was felt as to the safety of the present structure. It speaks well for the modern structure to know that a severe fire was confined to one floor of a cut-off fire section, and so far as actual fire damage was concerned, to a single suite of offices on the thirty-fifth floor. There was, however, some smoke and water damage to other portions of the same floor and to the floors above and below, and a heavy fire and water damage to the pipe shaft where the fire originated and water damage to the lower floors of the building. The fire in the file room on the thirty-fifth floor adjacent to the pipe shaft was very severe and destroyed practically all of the contents of that room excepting contents of two safes. The damage to the structure itself is comparatively slight. The work of the fire department in controlling and extinguishing the fire, described by Chief Kenlon as "the highest the world has known," is worthy of the highest commendation. The rescue of the workmen trapped in the pent-house forty stories above the street was thrilling and it is remarkable that no fatalities or serious injuries were recorded.

The building is a superior type of fire-resistive construction, including incombustible trim and floors throughout, with standard protection at the main floor openings, and is divided into four nearly equal fire sections above the first story by eight inch brick walls with standard automatic fire doors on one side of the wall at all openings. Automatic sprinklers are installed at a few places to protect special hazards, but no sprinklers were installed at points involved in the fire.

The standpipe system consisted of four six-inch standpipes in stair shafts with 2½ inch outlets on each floor and four on roof with reducing

couplings and 150 feet of 1½ inch standard hose at each outlet. The standpipes are supplied by eight-inch pipe from two 12,500 gallon tanks on 41st floor, with a total of 10,000 gallons reserved for fire purposes. Standpipes are cross connected at 36th intermediate and second sub-basement floors; reducing valves are located on the 7th, 18th and 28th floors. The standpipes are also supplied directly by eight-inch discharge pipe from 22 x 12 x 18 fire pumps, capacity 1,000 gallons per minute each; these pumps take suction from two 7,500 gallon tanks, supplied in turn from four six-inch connections to the city mains. Supply to standpipes is also available by four Siamese Fire Department connections, one located on each street front. There were numerous first aid appliances distributed throughout building and watchman's service with 44 stations, also National District Telegraph Co.'s fire alarm boxes and a private fire brigade. The building is located in the High Pressure District.

The Pipe Shaft.

Extending from the engine room in the second sub-basement up through the roof structure to the roof is a 12 by 12 foot pipe shaft. Three sides of the shaft are constructed of 6 in. hollow tile blocks, while the fourth side, which is an enclosing wall of an elevator shaft is 8 in. brick. The shaft is entirely open to the second sub-basement. At the top it is roofed over except for a hooded metal vent two feet in diameter and a four by five foot metal louver. The louver has swinging sheet metal shutter operated by a chain located inside of the shaft at the top floor level, arranged so that the louver can be entirely closed. At intervals of three to five floors there are door openings leading to the floors, protected by hollow metal fire doors with three point latches. Grid irons are located at each floor level supported on exposed steel I beams in the shaft and connected by vertical iron ladders. The shaft, while it acted as a vent for the engine room in the second sub-basement, was used as the main pipe shaft and contained numerous pipes covered with various types of pipe coverings. In the shaft was one 20 in. steam exhaust main and one 12 in. steam vent covered with magnesia block and canvas; one 2½ in. steam line, one 3 in. steam return line, one 4 in. drip from steam header and six 3 in. hot water supply and circulating lines, all insulated with magnesia covered with canvas; two 2½ in. brine lines insulated with cork covered with canvas; one 12 in. and one 18 in. soil and back air lines, one 2½ in. air line and one 5 in. illuminating gas line, all without coverings; one 6 in. high level, one 6 in. intermediate level and one 6 in. low level cold water supply lines with condensation insulation covered with canvas. There was also an independent electric line for lighting the shaft, enclosed in iron conduit.

Prior to the fire one of the 6 in. cold water supply lines loosened from its hangers on the grid iron beams and slid several feet downward

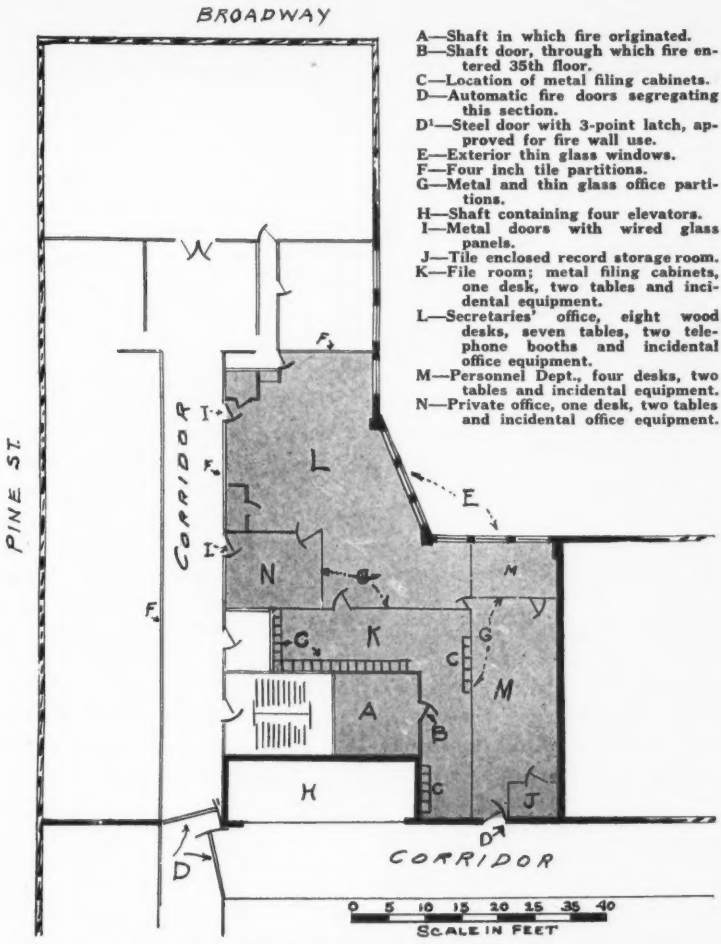

BROADWAY
PINE ST.
CORRIDOR
CORRIDOR
A—Shaft in which fire originated.
B—Shaft door, through which fire entered 35th floor.
C—Location of metal filing cabinets.
D—Automatic fire doors segregating this section.
D¹—Steel door with 3-point latch, approved for fire wall use.
E—Exterior thin glass windows.
F—Four inch tile partitions.
G—Metal and thin glass office partitions.
H—Shaft containing four elevators.
I—Metal doors with wired glass panels.
J—Tile enclosed record storage room.
K—File room; metal filing cabinets, one desk, two tables and incidental equipment.
L—Secretaries' office, eight wood desks, seven tables, two telephone booths and incidental office equipment.
M—Personnel Dept., four desks, two tables and incidental equipment.
N—Private office, one desk, two tables and incidental office equipment.
0 5 10 15 20 25 35 40
SCALE IN FEET

Fig. 2. Plan of 35th floor of Equitable Building, showing portion involved in fire. Shaded area shows extent of actual fire damage, which was most severe in the file room "K". There was also considerable smoke and water damage to the offices in this fire section.

in the shaft. Two crews of plumbers were put to work to make repairs. The crews were detailed to work in the lower and higher portions of the shaft respectively. These men entered the shaft from the third floor doorway and from the 35th floor doorway. The preparatory step taken by the workmen was to strip the pipe of its insulating covering. This consisted of paper and felt and an outer canvas covering (about one inch

over all) and was piled upon the grid irons at the floor levels as the work progressed. The crews employed the use of portable cord connections carrying electric bulbs and it was the practice to use the stationary light on the particular floor where they were working for general illumination and connect the portable cord connections (15 to 20 ft. lengths) to an outlet on either the floor above or below, or both, for concentrated light for the work in hand. No. 14 solid rubber covered wire was used, which is subject to kinking. A short circuit developed in one of the cords in use by the lower crew when they were at the 8th floor level, about midnight, but it is claimed it was detected and a new cord substituted.

Gasoline torches were to be used in the repairs but it is claimed that the work had not progressed to the point where they were necessary and that the appliances had not been taken into the shaft. Examination of the torches found in the basement indicates the statement to be true.

The Story of the Fire.

According to the testimony brought out by the investigation, the fire was discovered by the men in the lower portion of the shaft who were then working at the third floor level. It was described by one of them as originating from a flash and when first detected appeared to be at about the first floor level. One of the men descended the shaft to notify the engineer in the second sub-basement and in so doing passed the fire at the point of origin. This man was evidently very much excited at the time, for he cannot state what it was that appeared to be burning or give any definite details as to exactly what happened. One of the remaining men of the lower level crew drew two pails of water, which he threw at the fire, without result, and the crew left the shaft at the third floor level and closed the door to a locked position. The upper crew were trapped in the shaft and climbed up the ladders to the upper story of the pent house, where they left the shaft by the doorway, which they closed, smashed a window in the pent house and climbed out on the narrow ledge, from which they were subsequently rescued by the firemen. It is stated that they clung to the ledge for at least a half hour. As previously stated, the upper crew entered the shaft at the 35th story and did not close the door to a locked position. This type of door locks itself upon closing by a mechanical device in the form of a striking plate on the edge of the door, which throws the bolts into place in the door frame. Examination of this door shortly after the fire showed that the bolts had not been thrown, that the door had not been pried open and that it had been left open when the men entered. The doorway opened directly into the file room of the offices into which the fire entered.

The fire originating below the level at which the men were working might lead to the theory that perhaps they had been smoking and dropped

Fig. 3. The file room where the greatest damage occurred. This photograph shows a single walled metal filing cabinet with its back against a tile partition. It is claimed all drawers were closed and in a number of instances the drawers were fitted with individual locks. The picture also shows the steel girder where fireproofing was knocked off, and some of the tile archs where lower shells were broken. The two breaks shown are the most severe.

a lighted match or cigarette upon the flammable material beneath them. They steadfastly claim that they were not smoking and strengthen their claim by saying that because of the heat in the shaft, due to the various steam pipes, which made it uncomfortably warm, they had no desire to smoke.

The fire having started almost at the bottom of the shaft found plenty of material in the form of the paper and felt pipe covering piled upon the grid irons and the other pipe coverings to feed upon, and aided by a strong natural draft, it quickly spread up the shaft. Temperatures were reached by the burning material to cause twisting and expansion of the five inch uncovered gas line. The expansion subsequently ruptured the line at the 10th floor level and dropped the lower section of the pipe at the break about 19 inches. That this pipe had parted was not known until the day after the fire. Failure of gas flow from the piping in the Club on the upper floors caused an investigation by the management and it is stated they removed some 65 or 70 gallons of water from the pipe and the

meter. The water discharged into the shaft by the fire department during the progress of the fire, collected in sufficient quantity in the open end of the lower broken gas pipe to cause a water seal, extinguishing the blaze and preventing further flow of the gas. A comparison between the normal quantity of gas regularly used by the Club and that calculated from the meter reading taken after the fire, indicates that about 8,750 cubic feet of gas above the normal usage escaped from the gas pipe during the fire and was consumed. This unquestionably accounts for the high temperatures that were developed in the shaft.

After the engineer was notified by the workman that went down the shaft, an attempt was made to extinguish the fire by the local fire brigade. It is stated they first visited the 3rd floor door opening in the shaft, but were unable to open the door because it was expanded by the heat. They then went to the 15th floor and being unable to open the door, broke a hole in it and inserted the nozzle of a 1½ in. hose from the building equipment. They then went to the 24th floor and were unable also to open this door. The fire in the shaft at this time had gained great headway and they decided to call the fire department. From the time the man went down the shaft to notify the engineer until the alarm of fire was turned in, it is estimated that 12 minutes had elapsed.

Upon the arrival of the fire department practically the entire shaft and the quarter portion of the 35th floor were enveloped in flames. The standpipes of the building were utilized to extinguish the fire. The regular water supply of this equipment was augmented by connecting lines from the high pressure system. The fire was under control in about one hour after arrival of the fire department.

Damage.

The damage was confined chiefly to the shaft and the quarter portion of the 35th floor. Heat caused the automatic fire door in the dividing wall to close and because of this protection the fire did not spread beyond the one section.

Many of the pipes in the shaft are broken, their insulation has been burned and washed off and shaft itself is pierced in several places due to the twisting by heat of the angle iron supports of the iron grills. The doors in the shaft, although they prevented the fire from entering at their respective floors, are badly damaged by heat and by having been forced open by the fire department. On the 35th floor, where the shaft door was open, all of the office equipment located between the brick division wall and the corridor (see Fig. 2) was practically consumed. The heat developed by the fire in this file room was severe and perhaps might fairly be compared with the heat developed in a furnace or incinerator. The equipment consisted chiefly of wooden office furniture, shelving, etc.,

Fig. 4. A view of one of the drawers in the filing cabinet where contents was not totally destroyed, but the records are substantially worthless. This particular drawer is the fifth drawer from the bottom on left side as shown in Fig. 3.

and included in the equipment were a number of steel filing cabinets (see Fig. 3) backed up against the tile partition of the pipe and stair shaft. It is claimed by the occupant that all the drawers had been tightly closed and that many of them had been locked. The heat from the fire buckled most of them, or in any event fire entered or sufficient heat was transmitted to totally consume the records in some and so badly damage those in others that they were practically worthless (see Fig. 4). The remaining offices in this fire section of the building were badly water soaked and damaged by smoke. The fireproofing on the lower flange of one girder in the file room was almost entirely knocked off and the shells of the tile blocks in the floor arches are broken in about 48 places. The contents of two safes in the file room are said to have been removed without damage. It is quite probable that a large part, if not all, of the tile floor arches directly above the file room will have to be replaced. The damage to the floor below (the 34th floor) was largely caused by the water that seeped through the floor.

Property Loss.

The building is owned by the Equitable Office Building Corporation and is insured for $16,000,000. The contents of the 35th floor was also

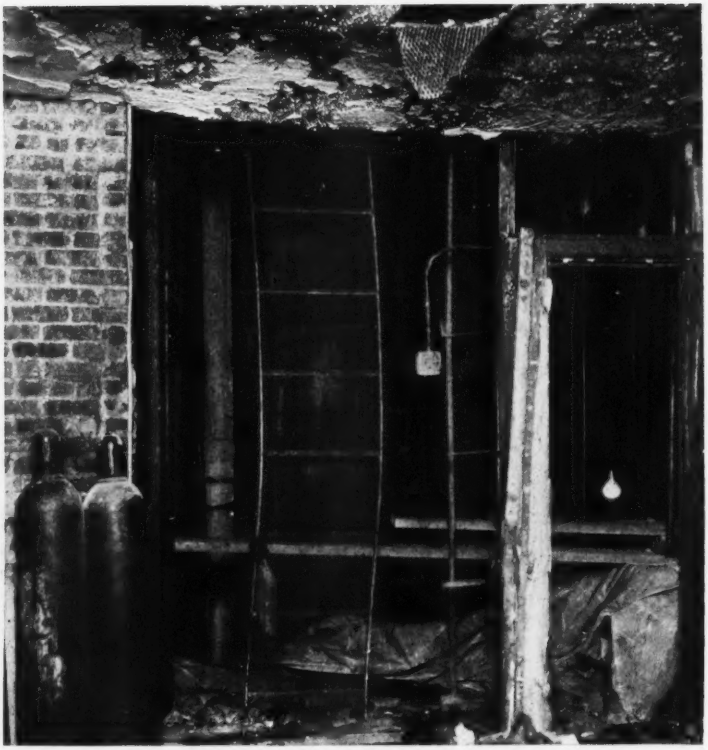


Fig. 5. The pipe shaft at the 35th floor when the front wall was removed after the fire. The tanks of oxygen and acetylene shown were used by the mechanics incident to this work.

insured and the amount is said to be $50,000. The loss has not been settled and the exact extent of the damage in the pipe shaft has not been fully determined. Estimates place the loss on building at between $60,000 and $80,000 and on contents of 35th floor at about $25,000. There are also claims on other floors which appear as minor.

Conclusions.

That this fire did not attain more serious proportion is a tribute to the building from the viewpoint of fire-resistive construction. It nevertheless emphasizes that security from fire loss lies not alone in the construction of the building, but also in the elimination of combustible contents of such a building.

It shows that offices in fire-resistive buildings, generally considered as presenting very little attraction for a fire, may contain sufficient flam-

mable material or contents to cause a very hot fire, sufficient in proportions to entirely destroy or badly damage the furnishings and contents.

It shows that the meaning of the word "fireproof" is very generally misconstrued. Where combustible material exists, there always exists the possibility of fire.

The introduction of flammable material, either in the form of pipe coverings or any other form into a pipe shaft, invites trouble and if ignited may be the cause of a disastrous fire.

Shafts of any nature that extend through a building should at least be closed at their lower extremity and should not be roofed over with any material that will not readily vent the shaft in case of fire. Insufficient vent area at the top of a shaft invariably causes fire to mushroom and find its outlet at some lower point.

It is to be regretted that the fire door leading to the shaft at the 35th floor was left open. It is difficult, however, to furnish equipment that will eliminate the human factor.

Single walled metal filing cabinets filled with combustible papers afford substantially no protection to the contents. The cabinets in this fire were badly distorted from the heat. If fire did not communicate direct, the transmitted heat was sufficient to practically destroy the contents.

Recommendations and General Statements.

"Fireproof" Building—There is no such thing as a fireproof building. A building may be able to resist fire to itself, but when it contains combustible contents the damage is likely to be severe from the high temperatures that occur.

Wired Glass Windows—Wired glass windows of proper design are an admirable means of mitigating the rapidity with which a fire can spread. In this case the fire on the 35th floor undoubtedly spread rapidly because the thin glass in the exterior windows broke early from the heat and aided materially to the combustion. While the fire did not overlap to any extent to the floor above, it might easily have done so under less favorable wind conditions.

Automatic Sprinklers—Automatic sprinklers are to be regarded as the best type of automatic private protection. No exception would seem warranted even in the case of office buildings containing combustible contents, and more especially high buildings.

Filing Cabinets—Single walled metal filing cabinets filled with papers and placed in a room having combustible furnishings and more or less loose records in the open, failed to protect the contents.

Division of Area—The division of this building into four fire sections (above the 1st story) was a very wise precaution. The fire door functioned as its design expected and prevented the spread of fire to the other three sections.

Pipe Shafts—The location of the door openings in the pipe shaft, even though protected by standard fire doors, proved a mistake. The possibility of such doors, especially when leading to private rooms containing combustible contents, being left open, as occurred here, or being blocked open, is evident. Besides, the delay in

obtaining access through private rooms by the Fire Department is an important feature. Had these doors been located in the stair shaft the fire would not have reached the office portion and damage by fire would have been materially less; also easier access could have been obtained by the Fire Department, resulting in the quicker application of water from hose streams from the standpipe equipment located in the stair shaft. At any rate, the door might have closed if it had been provided with a standard door check equipped with fusible link.

STANDPIPE LINES—The standpipe lines were perhaps the all important feature in fighting this fire. Had any defects existed in the piping or valves the result would have been the loss of much valuable time and undoubtedly greater fire loss. The successful operation of the fire department is almost wholly dependent upon standpipes in buildings above the 7th or 8th story, therefore, the reliability of all standpipe lines in all high buildings should be determined by periodical test. So far as New York City is concerned there appears to be no practice of systematically testing the reliability of standpipes or their valves after the test at their original installation. The ordinances simply provide that the responsibility for their maintenance rests with the person in charge of the building. A periodical test of standpipes and valves should be made by some properly constituted city department, possibly the fire department is better equipped and probably the most competent to make such test.

GAS LINES—The fire demonstrates the necessity of protecting gas lines in pipe shafts by adequate fireproofing to prevent undue expansion or rupture in case of fire.

PIPE COVERINGS—The fire also demonstrates the dangers of employing readily combustible materials for insulating pipes of any kind.

VERTICAL FLUES—Pipe shafts extending and forming a flue through a high building should be blocked at the lower extremity and have at the top a three-fourths area skylight glazed with thin glass, which in case of fire would easily break and vent the fire to the outside air.

PORTABLE ELECTRIC LIGHTS—Are probably a necessary evil. There is no good reason, however, why they cannot be used with perfect safety if materials approved for the purpose are employed, and the "portable" is given reasonable care.

It is fair to say in conclusion that it is doubtful if one was asked in advance, that this fire starting where it did, could have effected so much damage. The pipe shaft was of recognized good construction and had excellent protection at its door openings and it would have seemed entirely probable that a fire after it started should have been confined to the shaft and vented itself to the outside air through the top. This in spite of the fact that the area of the roof outlet was not adequate. The fact that the building itself withstood a severe fire with comparatively slight damage is a tribute to the modern methods of the so-termed fireproof constructed building. The heavy loss in the pipe shaft is due to rather unusual conditions and the misfortune of a break in a large gas line that could not readily have been foreseen.

Galveston Wharf Fire.

(Mallory Line Piers.)

By H. Oram Smith, Chief Engineer.

Texas Inspection Bureau. (Member N.F.P.A.)

The Mallory Line steamship dock, comprising Piers 23, 24, 25 and 26 of the Galveston water front, was destroyed on the night of January 13, 1926, in a characteristic waterfront fire which again demonstrates the fallacy of housing large values of cotton and miscellaneous merchandise in wooden sheds cut off from all avenues of approach by a network of railroad tracks and shifting freight trains. Investigation develops the fact that there was a delay of 16 minutes between the first alarm and the first stream of water; these 16 minutes represent the difference between what should have been a negligible loss, and what proved to be a loss of considerably over half a million dollars. With a watchman on the spot at the first smell of smoke, a central station alarm box at hand, adequate supply of inside standpipe and hose, water barrels and pails, and a fire boat berthed at the pier not 100 feet away, there appears to have been no real effort made to check the fire until the belated arrival of the fire department.

Construction.

The building was of the usual light shed construction, one story high, built in 1901, extending along the edge of the ship channel from the east side of 23rd Street to the west side of 26th Street, a distance of about 1,400 feet in length, and from 185 feet wide at the east end to 235 feet wide at the west end, or approximately 260,000 square feet. It was divided into two nearly equal sections by a 9 inch wooden bulkhead or division wall formed of 2 x 9 inch planks laid flat and bolted together, extending two feet above roof and eight feet beyond face of wall on north and south sides; there was one communicating opening large enough for the passage of trucks, protected on each side of wall by tin clad wood core fire doors of unapproved design and size, but in good order and fairly effective. The walls were of one inch boards on wood studding and timbers, open interior finish unpainted. The roof was composition and shell on one inch boards on wood rafters supported on wood trusses and posts; a monitor skylight 32 feet wide and eight feet high extended the entire length of the building with wired glass side lights in wooden frames; there was also a superstructure in the roof of the east section near the bulkhead wall, forming a second story office, 26 x 100 feet, 12 feet high, built of one inch boards on wood studding with wood sheathed

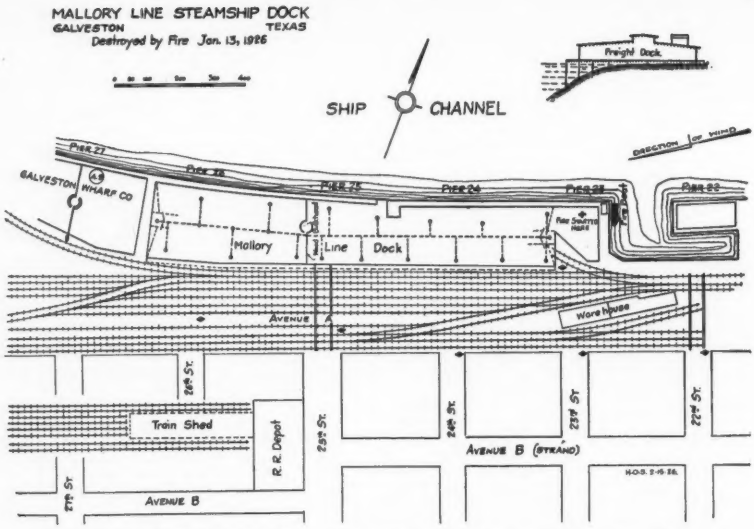


Diagram showing vicinity of the piers with intervening railroad yards cutting off approach and access to hydrants, 22nd and 25th Streets being the only available crossing. (See Frontispiece for photograph of this area.)

interior finish and thin glass windows all sides, reached by an open stairway from the dock; the roof proper projected eight feet beyond the south wall forming an awning the entire length of the building on the shore side. The floor was built of 3 inch single plank on heavy joists, supported on heavy creosoted timbers, girders and piling, filled in four feet above grade on the shore side, and extending over the water above high tide level.

Location and Approach.

The piers are practically isolated with the water on the north side and railroad yards on the south side; these yards are from 200 to 250 feet wide, completely filled with tracks and long strings of freight cars; some of these tracks extended into the pier shed from the east end for half the length of the building; all streets approaching from the south come to a dead end at the yards. The only direct thoroughfare is at 25th Street where the road is graded across the tracks into the pier. There is another crossing at 22nd Street, one block east of the pier, and one at 29th Street, three blocks west; these crossings are subject to continual obstruction and at time of fire the department was seriously hampered by switch engines pulling cars out of the fire area.

Occupancy.

The piers are owned by the Galveston Wharf Company and are under lease to the Mallory Steamship Company for general marine freight and transportation. Under normal conditions there is never any great accumulation of merchandise except the concentration of outgoing freight which is never excessive due to frequent sailings. At date of fire the S.S. Neuces had loaded and cleared port and the S.S. Concho had arrived and was discharging; being mostly L.C.L. shipments the cargo was to a great extent passed along into freight cars in the shed, and as these cars together with the ship and its unloaded cargo were salvaged, there was a comparatively small amount of freight lost. This loss has been estimated as high as $100,000, but no figures are available. The largest item of value was in baled cotton of the Oklahoma Cotton Growers' Association, stored in the east end of Pier 23 where the fire started. This was not supposed to be a permanent storage; it was claimed to be only a temporary concentration while awaiting more available space. At time of fire there were 4,372 bales tiered five to eight high; this tiering proved of value in protecting a great many of the inside bales from fire and water damage.

Value Involved and Amount of Loss.

The property involved was practically a total loss; the building, which was completely destroyed, showed an appraised value, after deducting 30% depreciation, of $220,780.50, and was covered as item 16 in the general schedule of the Galveston Wharf Co. for $200,000; there were also 10 empty freight cars of the railroad companies destroyed. There is no way to determine the loss of freight from the S.S. Concho, but estimates vary from $50,000 to $100,000. The cotton on hand was valued at $512,000, on which marine insurance of $448,000 was paid. The damaged cotton was turned over to a salvage company and sold, the amount of salvage being approximately 30 per cent.

Protection.

Public protection was city water at 90 pounds fire pressure with eight two-way and steamer connection hydrants within 500 feet, on 6, 8 and 10 inch mains. There was a fire department station five blocks distant with pumper. A fire alarm box was one block away. The fire tug Charles Clark, used as a tow boat between 6 A. M. and 6 P. M., equipped with two 1500 g.p.m. Underwriters' steam fire pumps, was stationed at Pier 23.

Private protection consisted of 23 inside standpipes with 50 feet of 2½ inch hose attached to each. One hundred water barrels and 400 pails were distributed on the wharf. A watchman was on duty at all times, reporting to A. D. T. central station from eight stations.

The Story of the Fire.

The cause is supposed to have been spontaneous ignition, or possibly a smouldering cotton "gin bale" fire. The premises had been inspected by the Texas Inspection Bureau a month before the fire and no unusual or unsatisfactory conditions had been found; there was no sampling, picking or reconditioning done and the premises were clean; the piers are policed day and night and smoking was strictly prohibited.

The night watchman reports having smelled burning cotton in the northeast corner of Pier 23 and spent some time in the vicinity in an effort to locate the fire. Failing to do so, he pulled a watchman's box reporting to the American District Telegraph Co. central station at 11:14 P. M. This call went in as their box 226 and was immediately relayed to the fire station as fire alarm box 422, which is the box designated on the fire department directory for Pier 23, but the night operator at the fire station sent the alarm out as box 423, sending the apparatus to the extreme west end of Pier 26. The apparatus made the run through 25th Street, into the pier shed and down to the 26th Street end. They appear to have spent enough time there making inquiries for an assistant chief to run to the 23rd Street end and back again, and then had to back their apparatus up to the 25th Street exit, recross the tracks to Strand Street, run east to the next crossing at 22nd Street and double back to the pier, being held up by moving trains at each crossing.

In the meantime the watchman had pulled his box a second time and the A. D. T. office telephoned the fire department and verified the box call; the night operator claims they told him then that the fire was in Pier 26 and he acted accordingly. The A. D. T. office disclaims any reference to Pier 26 in their telephone call and there is evidence that the apparatus had been sent to Pier 26 before this telephone call was received. The operator also stated that he had a later telephone call from the crew of the fire boat at Pier 23 advising them to hurry apparatus as the pier was on fire, and that this call came in exactly 15 minutes after the first box call, but no apparatus had as yet reached the scene. The fire apparatus did arrive within the next minute, however, and on opening up the doors at the east end the flames burst out over that end of the shed. The fire immediately burned through the outside wall of building at the northeast corner and as the wind was from that quarter it fanned the fire and swept it along the full length of the pier.

The tug Charles Clark was originally installed as a fire boat, with a station located in an iron clad shed at the end of Pier 23, where the tug is berthed at night; this station is still equipped with an alarm tapper and telephone and receives all city alarms. The tug has since been leased to a

towing company, with a cruising area restricted to the channel from Pier 10 to Pier 41 and is supposed to maintain a crew of six men subject to fire call at all times. At the time of fire the tug was in its berth but had only two inexperienced men on board, and the fire chief stated that while he was the last one to reach the scene, he was the first to get the tug's streams into action. In the meantime a general alarm had brought out the entire department, but with the exception of one hydrant adjacent to the end of Pier 23, all hose lines had to be extended across the tracks from the south side of the railroad yards; switch engines were constantly running through the yards pulling loaded freight cars out of the fire area and cutting the hose; this caused delay in replacing hose lines, but at that time the pier shed was practically doomed and the loaded freight cars represented values of considerably greater importance. The vital delay caused by the railroad tracks was on the initial run, making three crossings and being held up each time.

From all accounts this fire got away from a small start due to a series of errors; when the first company finally arrived and opened the east end doors, allowing the first rush of air in, the fire was beyond them, and before other companies arrived the fire had burned through the outside wall, letting in a brisk northeast wind which drove it ahead and completely out of control. The fire chief stated that before the fire had reached the wooden bulkhead wall the men had to drop their hose and escape, by crawling out on their hands and knees, using the hose lines as a guide through the smoke. The only redeeming feature was the saving of Pier 27, of iron clad construction, full of cotton at the time and detached only 28 feet from the west end of Pier 26; this pier is equipped with automatic sprinklers and by knocking the heads off the end lines it was possible to keep the inside of the wall wet, while the firemen and the tug concentrated their streams on the end wall of Pier 26, keeping it so wet that it stood up and formed a heat barrier.

Conclusions.

The contributing factors in this loss are, lack of initiative on the part of the watchman in waiting too long after detecting smoke before turning in the alarm, failing to use his first aid equipment or call help from the adjacent fire tug. The complete failure of the so-called fire boat as a unit of the fire department, with four of its crew reported to have been attending a picture show in town and its two remaining crew not sufficiently experienced to act until the fire department arrived, proves the fallacy of maintaining a fire boat that is not strictly under fire department training and discipline. Error and confusion in transmitting the alarm, apparently on the part of the night operator of the fire department, in sending the apparatus to a point remote from the fire, entailed a loss of 16 minutes in

getting water on the fire. Wide railroad yards and shifting freight trains cut off all avenues of approach and delayed apparatus that had already lost time. Light frame construction, which, considered in connection with cotton storage, offers a combination for rapid combustion that even under most favorable conditions may not be checked.

A glance at the airplane photograph (Frontispiece) showing how practically isolated this pier is from reasonable access, offers the best possible argument for fire resistive construction of all wharf property; wharves and piers must of necessity be on the waterfront and surrounded by railroad tracks, and under the best possible system of arrangement and regulation of traffic, there will always be more or less obstruction to the approach of the fire department. It would, therefore, seem to be an economic necessity that wharf property housing high values in freight and ship cargoes be of the most modern fire resistive construction, with fire division walls reducing them to the most practicable minimum areas.

A Pyroxylin Lacquer Spray Fire.

By Western Factory Insurance Association.

(Member N.F.P.A.)

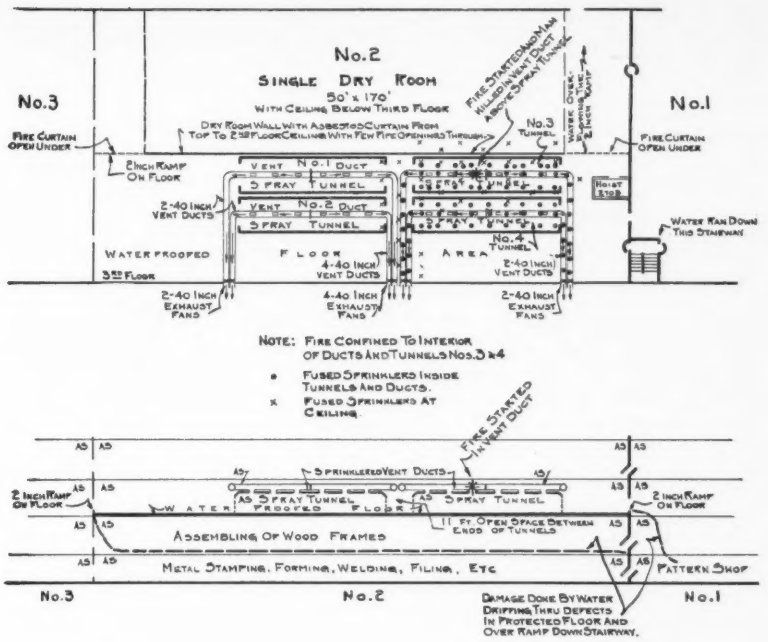
A fire on February 11, 1926, in a spray tunnel used for applying pyroxylin finish in an automobile body factory in the Middle West caused the death of one employee and the serious injury of another, but was extinguished with small property damage and furnishes an interesting demonstration of the efficacy of the various measures recommended by the N.F.P.A. pamphlet on Pyroxylin Finishes. If the principles set forth in this pamphlet had not been followed, a very heavy loss would have resulted.

One hundred and twenty-six sprinklers operated in one area over two other occupied floors and practically extinguished the fire with a loss of only $1800. The fire came when the factory was at the peak of a heavy production program. It occurred at 8:40 P. M.; manufacturing operations proceeded as usual the following morning.

Construction and Protection.

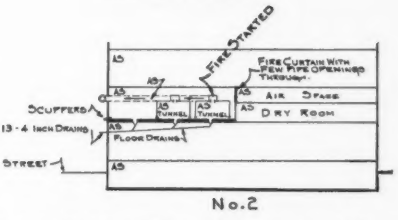
The building, shown by the accompanying plan, is three stories and basement, brick, semi-mill construction. Sprinklers are installed as shown on the plan, with special protection in the spray tunnels.

The spraying equipment consisted of four spray tunnels, of metal construction, set clear of the floor, 60 ft. long, 14 ft. wide and 7 ft. high, ventilated by horizontal metal ducts 30 to 40 in. in diameter. Each spray tunnel had two 40 in. inside exhaust fans located at outlet of ducts, belt


No.2
SINGLE DRY ROOM
50' x 170'
WITH CEILING BELOW THIRD FLOOR
No.3
No.1
FIRE CURTAIN OPEN UNDER
DRY ROOM WALL WITH ASBESTOS CURTAIN FROM TOP TO 2ND FLOOR CEILING WITH FEW FIRE OPENINGS THROUGH
FIRE STARTED AND MAN KILLED IN VENT DUCT ABOVE SPRAY TUNNEL
No.3 TUNNEL
WATER OVER-HEAD 2 INCH MAIN
2 INCH RAMP ON FLOOR
VENT No.1 DUCT
SPRAY TUNNEL
VENT No.2 DUCT
SPRAY TUNNEL
2-40 INCH VENT DUCTS
HOIST 5 TON
WATER RAN DOWN THIS STAIRWAY
No.4 TUNNEL
WATER PROOFED 3RD FLOOR
FLOOR AREA
4-40 INCH VENT DUCTS
2-40 INCH VENT DUCTS
2-40 INCH EXHAUST FANS
4-40 INCH EXHAUST FANS
2-40 INCH EXHAUST FANS
NOTE: FIRE CONFINED TO INTERIOR OF DUCTS AND TUNNELS NOS. 3 & 4
• FUSED SPRINKLERS INSIDE TUNNELS AND DUCTS.
× FUSED SPRINKLERS AT CEILING.
FIRE STARTED IN VENT DUCT
SPRINKLERED VENT DUCTS
2 INCH RAMP ON FLOOR
SPRAY TUNNEL
WATER PROOFED FLOOR
SPRAY TUNNEL
11 FT. OPEN SPACE BETWEEN ENDS OF TUNNELS
2 INCH RAMP ON FLOOR
ASSEMBLING OF WOOD FRAMES
METAL STAMPING, FORMING, WELDING, FILING, ETC
PATTERN SHOP
No.3
No.2
DAMAGE DONE BY WATER DRIPPING THRU DEFECTS IN PROTECTED FLOOR AND OVER RAMP DOWN STAIRWAY.
No.1

Plan of section involved in fire.

Approximate scale, 1 in. = 75 ft.



driven, with motors outside, ducts being divided above the center of the tunnel to divert the air suction equally to each fan, through horizontal openings in the bottom of the duct opening into the top of tunnels. Length of the north leg of duct of tunnel No. 3, where the fire started, was 75 ft., or a total length of 150 ft. for the entire tunnel. The combined length of ducts on the neighboring tunnel No. 4 was 110 ft. or a total of 260 ft. of duct involved in fire. The total length of ducts for all the tunnels was about 520 ft.

The spray tunnels occupied practically all of west half of the second floor of Building No. 2, the east half being equipped as the one-area dry room. Upon the request of the W.F.I.A., space between top of dry room and second floor ceiling had been fairly tightly sheathed off to provide a

fire curtain effect. Also upon request the entire west half of the second floor of Building No. 2 had been fairly well waterproofed (after equipment was in place) and scuppered, drained and inclosed in 2-in. high ramps or sills. Also upon request all vent ducts and spraying tunnels were equipped with wet system automatic sprinklers on individual pipe headers controlled by valves located on the floor below, fed from the riser supplying the building sprinklers. Requests for safe electric wiring and lighting were initially honored, but subsequently the use of defective devices, including open lights on extension cords, proved the initial cause of fire and loss of life.

The spraying equipment was modern, including closed pressure containers for supplying lacquers to spray guns, replacing former open gravity containers. Compounding and filling of containers being done in a segregated locality recently provided upon request.

The Story of the Fire.

The fire occurred in the second story (next to top floor) of the west half of Building No. 2, or in the heart of the congested metal and woodworking, erecting, assembling, trimming and finishing departments, all a single fire area.

The spraying operations ceased between 5 and 6 P. M., the exhaust fans being allowed to run for some time thereafter. Tunnels Nos. 1 and 2, where first coats of light consistency were applied, usually showed the smallest deposits of residues, while tunnels Nos. 3 and 4, where final coats of heavier consistency were applied, built up heavier deposits in shorter time.

As many as ten men could spray at one time in tunnel No. 3; but observations since the fire demonstrate that with fans kept running, all solvent vapors were removed from the booth within fifteen minutes after ceasing spraying operations.

Cleaning operations started about 7:30 P. M., at which time the foreman states that the atmosphere was cleared of all vapors by the fans then running. The usual method of cleaning ducts was to run fans and use air blast or hose, allowing fans to draw dust outdoors; the interior of the tunnels was cleaned by brushing down sides and tops with a broom. A cleaner had started work in the end of the vent duct farthest from the fan, standing on a ladder and partly entering the duct, using an unguarded electric light (probably a nitrogen lamp) on an extension cord of unknown character.

Fire occurred about 8:40 P. M. when the lamp was broken. At first it was a smouldering fire for a brief period but was quickly followed by a flash and explosion, fatally burning the man standing halfway in the duct and seriously burning his assistant who was cleaning in the tunnel

below. The flash quickly spread the fire over the residues (helped by suction fans in operation) to the balance of the ducts over tunnel No. 3 and in this tunnel and into tunnel No. 4 and in its ducts, which had the heaviest deposits and had not been cleaned. The flash and explosion was due probably to gases and smoke released by initial smouldering fire or by instant burning of suspended dust raised by air blast, or both.

The prompt opening of ceiling sprinklers outside the tunnels is probably responsible for keeping fire out of tunnels Nos. 1 and 2.

All sprinklers in tunnels Nos. 3 and 4 and in the ducts connecting the same opened promptly as well as ceiling sprinklers over and around these tunnels. The fire curtain and dry room partition prevented the opening of heads in the east half of room, excepting about six heads, and prevented overtaxing of water supplies and needless water damage. The fire department on arrival found it unnecessary to use hose, sprinklers having practically extinguished the fire, except in smouldering corners, where it was extinguished with chemicals. Sprinklers were shut off at post indicator valves about twenty minutes after the start of the fire, the heads were replaced and protection was restored by 1 A. M. The plant resumed operations the next morning without interruption to production.

The waterproofed floor consisted of two-ply tar paper with hot pitch applied to the old floor between the layers, with overlay of new T & G maple flooring on last coating of pitch. Failure to apply the finish flooring while pitch was still hot accounted for local defects developed in the floor. Floor drains and scuppers functioned satisfactorily but 2-in. ramps or sills were overrun by water from sprinklers, occasioning some water damage in floors below beyond the room affected by the fire.

The fire loss, $1800, consisted mainly in the replacement of sprinklers, spraying equipment and fan belts; also water damage to stock and the labor of salvaging stock.

Conclusions.

This fire justifies the opinion that had it not been for the timely effort made by the W.F.I.A. when the installation of the hazardous equipment was discovered, to secure safeguards still possible at that time, a tremendous water damage if not a partial destruction of the plant would have ensued as both buildings and contents are extremely vulnerable.

The use of unapproved and dangerous electric devices, particularly unprotected lamps, was primarily responsible for this loss of life and property damage.

The faulty design involving numerous large tunnel booths with excessively long horizontal ducts difficult to keep clean, can always be counted upon to produce results of this kind.

Attempts to maintain cleanliness proved inadequate because of the faulty design of the equipment, proving one of the primary causes of the extent of the fire.

The defects developed in the waterproofing of the floor under the tunnels demonstrate that where such waterproofing is undertaken it must be carefully carried out to insure its full efficiency. With the use of roofing felt and hot pitch it is absolutely imperative that the top flooring be laid while the pitch is still hot.

Closed pressure lacquer containers proved their efficiency over the old style suspended open cans by passing through the fire unharmed.

The dangerous properties of pyroxylin base enamel residues and differing entirely from the behavior of the paint and varnish and shellac residues are again demonstrated in this fire.

The need of waterproofing and protecting floors when dangerous spraying operations are located above ground floors is clearly proven by the curtailment of the damage in this case effected by the waterproof floor, even though it was not perfect.

The value of automatic sprinkler protection inside of ducts and booths as well as on the ceiling was amply demonstrated.

The value of draft curtains for confining heat waves is demonstrated, as well as the need of having such curtains tight, as in this case imperfections allowed sprinklers on the other side of the curtain to be opened.

The facts warrant the assumption that the public fire department had familiarized themselves with the locality, which resulted in quick, intelligent action on their part when the trouble came.

Fires in Which There Was Loss of Life.

These notes are intended to point out typical conditions under which loss of life has occurred, that they may be known and guarded against.

Children and Matches.

L-0004. FORT DODGE, IOWA, JANUARY 6, 1926. A five-year-old child was left alone in the kitchen while her mother was busy in another part of the house. She found some matches and in playing with them set fire to her clothing. The child was taken to the hospital, where she died from her burns. The mother, in trying to extinguish the flames, was seriously burned.

Gasoline.

H-22959. ROCHESTER, PA., FEBRUARY 15, 1926. An explosion, occurring in a jewelry store, caused by the fumes from a pan of gasoline igniting from a gas stove, caused the death of two people and serious injury to two others. The death of the owner of the store was caused from inhaling the poisonous flames and he was also badly burned externally. The other person who lost her life in the fire was a clerk in the store. She succeeded in getting to a window with her clothing a mass of flames, but the high window sill prevented her from clearing the opening. She was finally pulled through the opening, but she was so badly burned that she died two days later in the hospital.

Defective Chimneys.

L-0005. WINTHROP, MASS., JANUARY 29, 1926. A fire which started in the attic of the house, probably from a defective chimney, caused the death of one of the occupants and slight injuries to another. The owner, smelling smoke, rushed up into the attic and attempted to extinguish the fire with pails of water. He called for help and when aid reached him he was found lying unconscious in the midst of the flames. He was carried from the house and taken to the hospital where he died a few days later. Several of the firemen were cut by broken glass and others were frostbitten.

H-22957. HURLEYVILLE, N. Y., FEBRUARY 22, 1926. Eleven lives were lost in a fire which destroyed a hotel of stucco, wood frame construction. The fire apparently started from a chimney on a level with the third floor of the hotel. It spread rapidly through the top floor and

then downward through the center of the structure, cutting off the use of the stairways by the occupants. The alarm was delayed and by the time the firemen arrived the building was a mass of flames. Smoke seeping under the doors awakened some of the guests and many escaped by leaping from the windows. One of the men who sustained fatal burns escaped from the hotel and then returned to rescue other guests. He carried four women to safety before he collapsed. Several other men were seriously burned while attempting to aid other guests.

Ashes in Wooden Barrel.

H-22196. HYDE PARK, MASS., JANUARY 31, 1926. Live coals, placed in wooden barrels in a shed at the rear of the house, caused the death of three people. The barrels ignited, and before discovered the flames had reached such proportions that it was impossible for the family on the third floor of the building to make their escape. The son sacrificed his life in an attempt to save his mother and sister. He reached the window and was about to jump when he found that his mother and sister were still in the burning building. Outsiders begged him to jump but he went back and tried to find the other members of the family. His body was found a short time after on the floor of his mother's bedroom, where he had fallen in his effort to reach her. The mother and daughter were found lying on the floor near the bed. A blanket was wrapped around the mother's head to protect her from the smoke and flames. The daughter died that morning in the hospital. The mother and son were dead when they reached the hospital.

Oil Heaters.

L-0011. LONG BEACH, L. I., FEBRUARY 28, 1926. An oil heater, left burning at night, was thought to have been responsible for the loss of the lives of a man and his wife in a fire which destroyed their home. It is thought that the bungalow had become filled with carbon monoxide gas and that the man, who went to the kitchen to extinguish the heater, was overcome and upset the heater, which set fire to the woodwork. His body was found after the fire, where the kitchen had been, lying near a pile of twisted metal which formerly had been an oil heater. His wife's body was found in the bedroom terribly burned.

L-0001. WORCESTER, MASS., JANUARY 6, 1926. A fire, which started from the explosion of an oil heater that had been left burning behind a door in the front hallway, caused the death of three people. The family was asleep on the upper floor when they were awakened by the smell of smoke. When they reached the only stairway leading from the upper floor it was a mass of flames. Four of the members of the family covered

their faces and dashed down the stairs, while the others ran back to one of the bedrooms. A neighbor saw the fire and went to their assistance. He raised a ladder to the second story window and the occupants were assisted to the ground, but not before they had all been badly burned. Two women died almost as soon as they reached the hospital and a boy died during the afternoon.

H-22921. WAKEFIELD, MASS., JANUARY, 6, 1926. One man was fatally burned and two others sustained severe burns when an oil burner they were testing in a gasoline station exploded and enveloped them in flames.

Hotel Fire.

H-22379. LONG BRANCH, N. J., AUGUST 16, 1925. Two firemen and a sixteen-year-old girl were burned to death, and two other firemen and two women injured, when fire destroyed a section of a hotel. The girl was burned to death as she returned to her room to get her clothing and money. The two firemen were killed when the roof of the dining room fell as they were fighting the fire from above.

Oil Lamp.

L-0010. CENTRAL BRIDGE, N. Y., FEBRUARY 17, 1926. A mother and six of her children were burned to death and the father and another man badly injured when they attempted to rescue them. The only member of the family to escape injury was a fourteen-year-old daughter who was awakened when the mattress of her bed caught fire. She escaped down the back stairs. The father tried to drag his wife to safety, but she struggled to return to the aid of her children, three of whom were trapped in the attic of the house. The other children, who lost their lives, were asleep on the second floor of the house. The fire started from the explosion of a kerosene oil lamp which was kept burning all night. The fire spread to adjoining buildings before it was brought under control.

Inadequate Exits.

H-22956. DEDHAM, MASS., FEBRUARY 20, 1926. With every means of escape cut off by the flames, the owner of a carpenter shop was burned to death in a fire which destroyed the frame building in which it was located. The fire was not discovered until after it had been burning for some time. It was not known for certain that anyone was in the building and it was not until the fire was extinguished that the badly burned body of the carpenter was found lying beneath the debris of what had been his shop. His shop was in the part of the building where the fire was the worst, and it is believed that he was entirely surrounded by fire before he realized his danger.

Annual Summary.

Statistics of Fires in Properties Having Automatic Sprinkler Protection.

NOTE.—These tabulations are made at the close of each year with the object of furnishing a basis upon which the virtues of the automatic sprinkler as an extinguishing agent can be estimated.

Section I is devoted to fires in which the behavior of sprinklers was, for the reasons given, unsatisfactory.

Section II is a statistical record of all reports of sprinkler fires in the files of the Association upon which the information obtained is sufficiently complete for statistical purposes.

In each table the results of the current year ending February 1, 1926, are given, and these are compared with the results of the total thirty year record ending at that time.

The annual sprinkler tabulation is published this year for the thirtieth consecutive year, a notable record in continuity of this activity of the Association. The tables show the actual fire experience with automatic sprinkler equipments in nearly thirty-five thousand fires. This is not intended as a complete statistical record of fires occurring in sprinklered properties; it includes only those fires reported to the Department of Fire Record in sufficient detail to give the data necessary for the tables. This is probably only a fraction of the total number of fires occurring in buildings under sprinkler protection, but with a total of 35,000 fires in the record and current reports being received at the rate of more than two thousand a year, there can be no doubt but that this summary as a whole is typical and completely representative. An exception to this statement may be made in the case of the detailed records of experience in some occupancies where only a comparatively small number of fires are reported. In order to maintain the continuity of the tables from year to year it is necessary to have every occupancy classification appear, even though there be but one sprinklered fire reported. It is obvious, however, that conclusions should not be drawn as to the effectiveness of sprinklers in an occupancy where the number of fires reported is so small that the efficiency percentage may be distorted by the results of some one unusual fire.

The several tables showing sprinkler performance are divided into columns of cases where sprinklers "extinguished fire" and cases where sprinklers "held fire in check," both of these being classed as satisfactory performance. The distinction between these two classifications is necessarily more or less arbitrary, depending upon the judgment of the original inspector. The great majority of the fires in the "held in check" columns are cases where hose streams or chemicals were used to extinguish fire in spaces which water from the sprinkler did not reach because of obstructions to distribution, concealed spaces or unsprinklered portions, but where sprinklers functioned satisfactorily in preventing the spread of fire.

The total number of sprinklered fire reports received during the past year is 2504. The number of fires in which the sprinklers were not a factor* or which were discovered and extinguished before there was sufficient heat to open the sprinklers was 516.

SECTION I.

Summary of Unsatisfactory Sprinkler Fires

	1925-1926		1897-1926, incl.	
	No. of Fires	Per Cent	No. of Fires	Per Cent
Water shut off sprinklers	31	43.7	441	30.2
Generally defective equipment	5	7.1	289	19.8
Unsprinklered portions	7	9.8		
Defective water supply or supplies	6	8.4	130	8.9
Sprinkler system crippled due to freezing	..	..	42	2.9
Slow operation of dry system or defective valve	1	1.4	38	2.6
Slow or defective operation of high test heads	1	1.4	25	1.7
Faulty building construction, concealed spaces, vertical openings, etc.	2	2.8	73	5.0
Obstruction to distribution	3	4.2	83	5.7
Hazard of occupancy too severe for average sprinkler equipment	3	4.2	86	5.9
Explosion crippled sprinkler system	4	5.6	64	4.4
Exposure or conflagration	..	..	72	4.9
Plugged heads (included with Miscellaneous prior to 1921)	..	..	11	.7
Miscellaneous	8	11.4	107	7.3
Total	71		1461	

Fires in Which Failure Was Due to Water Shut Off Sprinklers

	1925-1926 No. of Fires	1897-1926 No. of Fires
Water shut off for unknown reason, neglect or carelessness	7	155
Water shut off before fire was out or fire rekindled	4	68
Water shut off due to accidents or repairs	4	71
Water shut off to prevent freezing	11	97
Water shut off, probably incendiary	1	7
Water shut off, leaky dry system	..	11
Water shut off, miscellaneous	3	24
Water shut off, defective gate valve	1	8
Total	31	441

SECTION II.

Annual Revision of Sprinkler Fire Tables.

In the following tables is given a summary of fires occurring in properties equipped with automatic sprinklers. The total number of such fires reported during the past year is 2504, which includes 516 fires where no sprinklers were opened. Several reports were also received in which the data was incomplete, and these were not used in the summary. It may be noted that the total number of fires does not agree throughout all the tables. This is because some of the reports of fires prior to 1909 were not considered sufficiently complete to include in all the tables, and hence appear in some tables, but not in others.

*By "not a factor" is meant fires that occur in unsprinklered portions of a building.

Table No. 1—Number of Sprinklers Operating.

No. of Fires, 1925-1926

No. of Sprinklers Operating	Wet	%	Dry	%	No Data	Total	%
1	650	40.2	66	20.7	7	723	36.8
2	304	18.8	33	10.3	..	337	17.1
3	166	10.3	22	6.9	1	189	9.6
4	106	6.6	23	7.2	3	132	6.8
5	56	3.5	19	6.0	..	75	3.8
6	53	3.3	10	3.1	1	64	3.3
7	26	1.5	19	6.0	1	46	2.3
8	36	2.2	8	2.5	1	45	2.3
9	23	1.4	11	3.4	2	36	1.8
10	22	1.3	5	1.6	1	28	1.4
11	14	.9	6	1.9	..	20	1.0
12	8	.6	6	1.9	..	14	.7
13	10	.6	8	2.5	..	18	.9
14	17	1.0	10	3.1	..	27	1.4
15	11	.7	2	.6	..	13	.7
16 to 20	35	2.2	13	4.2	1	49	2.5
21 to 25	17	1.0	13	4.2	1	31	1.6
26 to 30	10	.6	8	1.9	2	20	1.0
31 to 35	7	.5	5	1.6	1	13	.7
36 to 40	11	.7	3	.9	..	14	.7
41 to 50	7	.5	2	.6	..	9	.5
51 to 75	12	.7	11	3.4	..	23	1.2
76 to 100	5	.3	4	1.3	..	9	.5
Over 100	10	.6	13	4.2	5	28	1.4
No Data	7		6		12	25	
Total	1623		326		39	1988	

No. of Fires, 1897-1926, inclusive

No. of Sprinklers Operating	Wet	%	Dry	%	No Data	Total	%
1	10289	36.7	1122	19.6	56	11467	33.8
2	5082	18.0	779	13.6	27	5888	17.3
3	2864	10.2	481	8.4	13	3358	9.9
4	1996	7.1	420	7.3	15	2431	7.2
5	1226	4.3	273	4.8	7	1506	4.4
6	996	3.5	255	4.5	6	1257	3.7
7	683	2.4	189	3.3	5	877	2.6
8	648	2.3	164	2.8	7	819	2.4
9	411	1.5	130	2.3	5	546	1.6
10	374	1.3	106	1.9	11	491	1.5
11	271	1.0	105	1.9	4	380	1.1
12	314	1.1	115	2.0	3	432	1.3
13	183	.7	89	1.6	5	277	.8
14	213	.8	93	1.6	2	308	.9
15	168	.6	89	1.6	1	258	.8
16 to 20	603	2.1	256	4.5	9	868	2.5
21 to 25	346	1.2	192	3.3	4	542	1.6
26 to 30	250	.9	123	2.1	7	380	1.1
31 to 35	160	.6	77	1.3	3	240	.7
36 to 40	145	.5	76	1.3	..	221	.6
41 to 50	168	.6	104	1.9	1	273	.8
51 to 75	242	.9	146	2.5	2	390	1.1
76 to 100	102	.4	74	1.3	3	179	.5
Over 100	358	1.3	263	4.6	9	630	1.8
No Data	43		37		414	494	
Total	28135		5758		619	34512	
Water shut off sprinklers						270	
		Total				34782	

Table No. 2—Number of Sprinklers Operating.

No. of Fires, 1897-1926, inclusive

No. of Sprinklers Operating	Wet	%	Dry	%	No Data	Total	%
1	10289	36.7	1122	19.6	56	11467	33.3
2 or less	15371	55.0	1901	33.3	83	17355	50.9
3 or less	18235	64.5	2382	41.9	96	20713	60.8
4 or less	20231	71.5	2802	49.0	111	23144	68.0
5 or less	21457	76.1	3075	53.8	118	24650	72.5
6 or less	22453	80.0	3330	58.2	124	25907	76.1
7 or less	23136	82.1	3519	61.5	129	26784	78.5
8 or less	23784	84.5	3683	64.5	136	27603	81.3
9 or less	24195	86.1	3813	66.5	141	28149	82.8
10 or less	24569	87.3	3919	68.5	152	28640	84.2
11 or less	24840	88.2	4024	70.5	156	29020	85.4
12 or less	25154	89.5	4139	72.1	159	29452	86.5
13 or less	25337	90.1	4228	74.0	164	29729	87.5
14 or less	25550	90.9	4321	75.6	166	30037	88.4
15 or less	25718	91.5	4410	77.2	167	30295	88.9
20 or less	26312	93.8	4666	81.7	176	31163	91.5
25 or less	26667	95.0	4858	85.0	180	31705	93.4
30 or less	26917	95.8	4981	87.0	187	32085	94.4
35 or less	27077	96.5	5058	88.7	190	32325	95.0
40 or less	27222	97.0	5134	89.5	190	32546	95.8
50 or less	27390	97.5	5238	91.5	191	32819	96.5
75 or less	27632	98.4	5384	94.0	193	33209	97.6
100 or less	27734	98.7	5458	95.4	196	33388	98.2
Over 100	358	1.3	263	4.6	9	630	1.8
No Data	43		37		414	494	
	28135		5758		619	34512	
Water shut off sprinklers						270	
Total						34782	

Table No. 3—Effect of Sprinklers.

	1925-26		1897-1926, incl.	
	No. of Fires	%	No. of Fires	%
Practically or entirely extinguished	1424	71.6	23267	66.9
Held fire in check	493	24.9	10038	28.9
Total Satisfactory	1917	96.5	33305	95.8
Unsatisfactory	71	3.5	1461	4.2
Total	1988		34766	

Table No. 4

Effect of Sprinklers by Class of Occupancy.

	Extinguished Fire		Held Fire in Check		Total Satisfactory		Unsatisfactory		Total No. of Fires
	No.	%	No.	%	No.	%	No.	%	
Agricultural Implements	54	57.4	35	37.3	89	94.7	5	5.3	94
Apartments	44	93.6	3	6.4	47	100.0	..	..	47
Artificial Leather	16	41.0	21	53.9	37	94.9	2	5.1	39
Automobile and Bicycle Factories	167	58.5	103	36.1	270	94.6	15	5.4	285
Awning Factories	6	66.7	3	33.3	9	100.0	..	..	9
Bag Factories	21	54.0	17	43.5	38	97.5	1	2.5	39
Bakeries	96	74.5	29	22.4	125	96.9	4	3.1	129
Basket Factories	7	87.5	1	12.5	8	100.0	..	..	8
Battery Works	16	66.7	7	29.1	23	95.8	1	4.2	24
Bolt, Nut and Screw Works	19	63.4	10	33.3	29	96.7	1	3.3	30
Boot and Shoe Shops	712	73.8	219	22.7	931	96.5	34	3.5	965
Bottle Caps and Seals	19	49.0	20	51.0	39	100.0	..	..	39
Bottling Works	5	83.4	..	....	5	83.4	1	16.6	6
Braid Mills	29	80.6	6	16.6	35	97.2	1	2.8	36
Brass Works	52	69.4	21	28.0	73	97.4	2	2.6	75
Breweries	5	83.4	1	16.6	6	100.0	..	..	6
Broom Factories	12	60.0	6	30.0	18	90.0	2	10.0	20
Brush Factories	26	72.1	10	27.9	36	100.0	..	..	36
Button Factories	58	81.7	11	15.5	69	97.2	2	2.8	71
Candle Factories	6	46.1	7	53.9	13	100.0	..	..	13
Candy Factories	141	72.3	48	24.3	189	96.6	6	3.4	195
Canning Factories	13	56.6	7	30.4	20	87.0	3	13.0	23
Car Houses	32	43.2	35	47.4	67	90.6	7	9.4	74
Car Works	83	61.5	47	34.8	130	96.3	5	3.7	135
Carpet Mills	173	62.2	95	34.2	268	96.4	10	3.6	278
Carriage and Automobile Body Factories	118	60.9	57	29.3	175	90.2	19	9.8	194
Celluloid (Pyroxylin Plastic)	170	67.0	58	22.8	228	89.8	26	10.2	254
Cement and Plaster Works	6	60.0	2	20.0	8	80.0	2	20.0	10
Cereal Mills	35	64.8	12	22.2	47	87.0	7	13.0	54
Chemical and White Lead	119	59.8	63	31.6	182	91.4	17	8.6	199
Clothing Factories	1517	85.0	254	14.4	1771	99.4	11	.6	1782
Clubs	13	72.3	3	16.6	16	88.9	2	11.1	18
Coffee and Spice Mills	58	66.6	25	28.8	83	95.4	4	4.6	87
Coffin Factories	59	73.0	20	24.5	79	97.5	2	2.5	81
Cold Storage Plants	7	58.5	5	41.5	12	100.0	..	..	12
Cooperage Plants	48	55.8	27	31.4	75	87.2	11	12.8	86
Cordage Works	225	64.5	111	31.8	336	96.3	13	3.7	349
Cork Factories	22	47.8	20	43.5	42	91.3	4	8.7	46
Corset Factories	11	68.9	4	24.9	15	93.8	1	6.2	16
Cotton Ginnery	8	61.6	5	38.4	13	100.0	..	..	13
Cotton Mills	4378	62.4	2566	36.4	6944	98.8	83	1.2	7027
Cotton Seed Oil Mills	39	47.6	29	35.4	68	83.0	14	17.0	82
Cotton Warehouses	150	45.7	151	46.1	301	91.8	27	8.2	328
Cutlery and Tools	26	63.4	13	31.7	39	95.1	2	4.9	41
Department Stores	463	78.3	110	18.8	573	97.1	17	2.9	590
Distilleries	8	66.7	3	25.0	11	91.7	1	8.3	12
Doll Factories	45	63.5	26	36.5	71	100.0	..	..	71
Drug Houses	191	80.5	42	17.8	233	98.3	4	1.7	237
Dry Cleaning Establishments	7	58.5	5	41.5	12	100.0	..	..	12
Dry Goods Stores	242	85.1	41	14.4	283	99.5	1	.5	284
Dyeing, Bleaching and Finishing	167	53.0	135	42.6	302	95.6	14	4.4	316
Electrical Appliances	252	68.6	108	29.5	360	98.1	7	1.9	367
Electric Light and Power Plants	6	40.0	7	46.6	13	86.6	2	13.4	15
Elevators, Grain	28	37.3	28	37.3	56	74.6	19	25.4	75
Excelsior Factories	25	73.5	6	17.7	31	91.2	3	8.8	34
Fertilizer Plants	28	63.6	12	27.3	40	90.9	4	9.1	44
Flax and Linen Mills	35	50.8	34	49.2	69	100.0	..	..	69
Flour and Grist Mills	69	56.7	36	29.5	105	86.2	17	13.8	122
Forge and Smithy	17	70.9	6	25.0	23	95.9	1	4.1	24

Table No. 4 — Continued.

	Extinguished Fire		Held Fire in Check		Total Satisfactory		Unsatisfactory		Total No. of Fires
	No.	%	No.	%	No.	%	No.	%	
Foundries	170	57.8	111	37.8	281	95.6	13	4.4	294
Fur Works	64	91.5	5	7.1	69	98.6	1	1.4	70
Furniture Factories	614	65.6	252	26.9	866	92.5	73	7.5	939
Furniture Stores	61	76.3	14	17.5	75	93.8	5	6.2	80
Garages	220	69.6	90	28.5	310	98.1	6	1.9	316
Garbage Reduction Plants	3	60.0	1	20.0	4	80.0	1	20.0	5
Gas Plants	2	66.7	1	33.3	3	100.0	..	..	3
General Stores	22	84.6	4	15.4	26	100.0	..	.	26
Glass Works	57	52.3	40	36.7	97	89.0	12	11.0	109
Glove Factories	13	76.5	3	17.6	16	94.1	1	5.9	17
Glue Factories	9	53.0	6	35.3	15	88.3	2	11.7	17
Groceries	112	81.2	20	14.5	132	95.7	6	4.3	138
Hardware Stores	76	86.4	11	12.5	87	98.9	1	1.1	88
Harness and Fancy Leather	131	82.4	27	17.0	158	99.4	1	.6	159
Hat Factories	203	76.0	52	19.5	255	95.5	12	4.5	267
Hatters' Fur Works	15	51.8	9	31.0	24	82.8	5	17.2	29
Hotels	41	77.4	10	18.8	51	96.2	2	3.8	53
Ice Plants	2	66.7	1	33.3	3	100.0	..	..	3
Incandescent Lamp Works	23	63.9	13	36.1	36	100.0	..	..	36
Institutions	11	73.3	3	20.0	14	93.3	1	6.7	15
Insulated Wire Factories	35	62.5	21	37.5	56	100.0	..	..	56
Jewelry Factories	148	86.7	17	9.8	165	96.5	6	3.5	171
Junk Shops	22	78.7	5	17.7	27	96.4	1	3.6	28
Knitting Mills, Cop Yarn	62	66.0	25	26.6	87	92.6	7	7.4	94
Knitting Mills, Full Process	516	65.7	244	31.1	760	96.8	25	3.2	785
Laundries	73	74.0	23	23.0	96	97.0	3	3.0	99
Lead Pencil Factories	16	66.7	7	29.2	23	95.9	1	4.1	24
Linseed Oil Works	18	53.0	12	35.3	30	88.3	4	11.7	34
Machine Works	319	67.0	131	27.9	446	94.9	24	5.1	470
Mail Order Houses	32	94.1	2	5.9	34	100.0	..	..	34
Match Factories	55	74.3	15	20.3	70	94.6	4	5.4	74
Mattress Factories	413	69.9	168	28.4	581	98.3	10	1.7	591
Mercantile (Miscellaneous)	706	81.0	145	16.5	851	97.5	22	2.5	873
Metal Reduction Works	11	68.9	5	31.1	16	100.0	..	..	16
Metal Workers†	873	64.5	424	31.4	1297	95.9	56	4.1	1353
Miscellaneous	543	72.0	168	22.5	711	94.5	42	5.5	753
Morocco Leather Shops	43	55.1	26	33.4	69	88.5	9	11.5	78
Motion Pictures	75	83.4	14	15.5	89	98.9	1	1.1	90
Multiple Occupancy	2	33.3	3	50.0	5	83.3	1	16.7	6
Munition Factories	22	41.5	22	41.5	44	83.0	9	17.0	53
Musical Instrument Factories	132	67.4	58	29.6	190	97.0	6	3.0	196
Office Buildings	47	88.7	6	11.3	53	100.0	..	..	53
Oilcloth and Linoleum Works	42	31.3	71	53.0	113	84.3	21	15.7	134
Oil Clothing Factories	12	66.7	5	27.8	17	94.5	1	5.5	18
Oil Refineries									
Animal	2	40.0	3	60.0	5	100.0	..	..	5
Mineral	6	75.0	2	25.0	8	100.0	..	..	8
Vegetable	3	27.2	7	63.7	10	90.9	1	9.1	11
Packing House and Slaughter	154	71.0	55	25.3	209	96.3	8	3.7	217
Paint and Varnish Works	209	67.1	91	29.1	300	96.2	12	3.8	312
Paper Box and Papeterie	219	76.3	62	21.6	281	97.9	6	2.1	287
Paper Mills	440	50.4	368	41.5	808	91.9	71	8.1	879
Patent Leather Works	11	36.7	15	50.0	26	86.7	4	13.3	30
Phonograph Works	22	75.8	6	20.8	28	96.6	1	3.4	29
Photograph Works	37	75.5	11	22.5	48	98.0	1	2.0	49
Picture Frame Factories	48	66.7	18	25.0	66	91.7	6	8.3	72
Piers and Wharves	6	35.1	9	53.2	15	88.3	2	11.7	17
Plumbers' Supplies	28	75.6	9	24.4	37	100.0	..	..	37
Potteries	47	63.5	22	29.7	69	93.2	5	6.8	74
Printing and Lithographing	769	82.0	151	16.1	920	98.1	18	1.9	938

Table No. 4 — Concluded.

	Extinguished Fire		Held Fire in Check		Total Satisfactory		Unsatisfactory		Total No. of Fires
	No.	%	No.	%	No.	%	No.	%	
Public Buildings	..	..	1	100.0	1	100.0	..	..	1
Pulp Mills	34	35.8	40	42.1	74	77.9	21	22.1	95
Railroad Property	2	33.3	3	50.0	5	83.3	1	16.7	6
Restaurants	60	76.0	17	21.5	77	97.5	2	2.5	79
Rice Mills	2	50.0	1	25.0	3	75.0	1	25.0	4
Rolling, Wire and Tube Works	34	58.5	22	38.0	56	96.5	2	3.5	58
Roofing Works	32	41.0	39	50.0	71	91.0	7	9.0	78
Rubber Cloth Factories	30	57.7	21	40.4	51	98.1	1	1.9	52
Rubber Reclaiming Works	7	35.0	9	45.0	16	80.0	4	20.0	20
Rubber Works	163	50.6	138	42.9	301	93.5	21	6.5	322
Saw and Planing Mills	89	43.0	68	32.8	157	75.8	50	24.2	207
Schools	13	81.3	3	18.7	16	100.0	..	..	16
Ships and Shipbuilding	5	41.6	6	50.0	11	91.6	1	8.4	12
Shoddy Mills	217	65.6	93	28.0	310	93.6	21	6.4	331
Shoe Stores	48	89.0	6	11.0	54	100.0	..	..	54
Silk Mills	100	76.9	26	20.0	126	96.9	4	3.1	130
Skin Mills	9	81.8	2	18.2	11	100.0	..	..	11
Soap Manufacturing	37	77.0	10	20.9	47	97.9	1	2.1	48
Stables	16	72.7	6	27.3	22	100.0	..	..	22
Stamping and Sheet Metal Works	88	62.9	40	28.5	128	91.4	12	8.6	140
Starch and Glucose Works	13	52.0	4	16.0	17	68.0	8	32.0	25
Sugar Refineries	31	59.6	19	36.6	50	96.2	2	3.8	52
Tanneries	46	50.0	38	41.3	84	91.3	8	8.7	92
Tenant Manufacturing	761	74.6	205	20.0	966	94.6	54	5.4	1020
Theatres	56	73.7	15	19.7	71	93.4	5	6.6	76
Tobacco Factories	64	72.0	22	24.7	86	96.7	3	3.3	89
Trunk Factories	29	72.5	8	20.0	37	92.5	3	7.5	40
Wall Paper Factories	20	69.0	5	17.2	25	86.2	4	13.8	29
Warehouses	409	70.5	142	24.5	551	95.0	29	5.0	580
Waste and Batting Mills	291	61.2	167	35.0	458	96.2	18	3.8	476
Waste Paper and Rag Shops	91	63.2	49	34.0	140	97.2	4	2.8	144
Weaving Mills	128	65.6	62	31.8	190	97.4	5	2.6	195
Window Shade Factories	12	85.7	..	....	12	85.7	2	14.3	14
Woodworkers, Class A*	163	55.3	91	30.8	254	86.1	41	13.9	295
Woodworkers, Class B*	159	52.7	114	37.8	273	90.5	29	9.5	302
Woodworkers, Class C*	139	60.7	78	34.0	217	94.7	12	5.3	229
Woodworkers, Class D*	100	58.2	53	30.8	153	89.0	19	11.0	172
Woodworkers, Class E*	191	66.4	84	29.1	275	95.5	13	4.5	288
Woodworkers, Class F*	40	61.5	21	32.3	61	93.8	4	6.2	65
Woolen Mills	974	69.9	353	25.3	1327	95.2	66	4.8	1393
Wool Storehouses	28	70.0	10	25.0	38	95.0	2	5.0	40
Worsted Mills	69	55.2	42	33.6	111	88.8	14	11.2	125
Total Sprinkler Fires	23,267		10,038		33,305		1,461		34,766

*The Woodworkers are classed as follows :

Class A. Interior Woodwork, builders' supplies (including veneer works).

Class B. Box Factories (including cigar boxes).

Class C. Miscellaneous Woodworkers. Steam power tenant Woodworkers. Woodworkers where there is a lack of detailed information as to class.

Class D. Sash, Door and Blind Factories.

Class E. Hard Wood Turning (wheels, pipes, novelties, bobbins, spools, etc., last and wood heel factories).

Class F. Pails and Woodenware (plates, wooden bowls, tubs, etc.).

†Other Metal Working Occupancies are included under Agricultural Implements; Automobile and Bicycle Factories; Bolt, Nut and Screw Works; Electrical Appliances; Forge and Smithy; Foundries; Machine Works; Rolling, Wire and Tube Works; and Stamping and Sheet Metal Works.

Table No. 5

Classification of Unsatisfactory Sprinkler Fires by Occupancy.

	Water shut off sprinklers.	Generally defective equipment and unsprinklered portions.	Defective water supply or supplies.	Sprinkler system crippled due to freezing.	Slow operation of dry system or defective dry valve.	Slow or defective operation of high test heads.	Faulty building construction, concealed spaces, vertical openings.	Obstruction to distribution.	Hazard of occupancy too severe for average sprinkler equipment.	Sprinkler system crippled by explosion.	Exposure or conflagration.	Plugged Heads.	Miscellaneous.	Total.
Agricultural Implements	3	1	..	..	..	..	..	..	1	..	..	..	..	5
Artificial Leather	..	..	..	..	..	..	1	..	..	1	..	..	..	2
Automobile and Bicycle	7	1	1	..	..	..	..	4	..	1	1	..	..	15
Bag Factories	..	..	..	..	..	1	..	..	..	..	..	..	..	1
Bakeries	2	1	..	..	..	..	..	..	..	..	..	..	1	4
Battery Works	1	..	..	..	..	..	..	..	..	..	..	..	..	1
Bolt, Nut and Screw Works	..	1	..	..	..	..	..	..	..	..	..	..	..	1
Boot and Shoe Shops	13	6	2	..	..	1	..	1	..	2	5	..	4	34
Bottling Works	..	1	..	..	..	..	..	..	..	..	..	..	..	1
Braid Mill	..	1	..	..	..	..	..	..	..	..	..	..	..	1
Brass Works	..	1	..	..	..	..	..	..	..	..	..	..	1	2
Broom Factories	2	..	..	..	..	..	..	..	..	..	..	..	..	2
Button Factories	..	..	..	2	..	..	..	..	..	..	..	..	..	2
Candy Factories	2	..	..	..	1	..	2	..	..	..	..	..	1	6
Canning Works	1	..	..	..	1	..	..	..	..	..	1	..	..	3
Car Houses	2	2	1	..	1	..	..	1	..	..	..	..	..	7
Car Works	2	1	..	..	..	..	1	1	..	..	..	..	..	5
Carpet Mills	4	2	3	..	..	..	..	1	..	..	..	..	..	10
Carriage and Automobile Body Factories	4	4	3	..	2	..	..	2	1	..	2	1	..	19
Celluloid (Pyroxylin)	1	1	3	1	1	..	2	2	8	5	2	..	..	26
Cement and Plaster Works	..	1	..	..	1	..	..	..	..	..	..	..	..	2
Cereal Mills	..	2	1	..	..	..	..	1	..	3	..	..	..	7
Chemical and White Lead	3	4	..	..	..	..	..	..	4	5	..	..	1	17
Clothing Factories	3	..	2	1	..	..	2	2	..	..	1	..	..	11
Clubs	1	..	..	..	..	..	1	..	..	..	..	..	..	2
Coffee and Spice Mills	2	..	..	..	..	..	..	1	..	1	..	..	..	4
Coffin Factories	1	..	..	1	..	..	..	..	..	..	..	..	..	2
Cooperage Plants	1	4	..	..	..	1	..	4	..	..	1	..	..	11
Cordage Works	4	4	1	1	..	..	..	2	..	..	..	..	1	13
Cork Factories	1	..	1	..	..	..	..	..	..	1	..	..	1	4
Corset Factories	..	..	..	..	..	..	..	..	..	..	1	..	..	1
Cotton Mills	28	21	7	2	1	1	5	1	3	..	..	2	12	83
Cotton Warehouses	14	1	2	..	..	..	1	4	2	..	..	..	3	27
Cotton Seed Oil Mills	3	5	2	..	..	..	..	..	1	..	..	..	3	14
Cutlery and Hardware	1	1	..	..	..	..	..	..	..	..	..	..	..	2
Department Stores	7	4	..	..	1	..	1	1	..	..	2	..	1	17
Distilleries	..	..	..	..	..	..	..	..	..	..	1	..	..	1
Drug Houses	..	..	..	..	..	..	..	..	..	..	3	..	1	4
Dry Goods Stores	..	..	..	..	..	..	..	1	..	..	..	..	..	1
Dyeing, Bleaching and Finishing	5	3	1	..	1	1	..	1	..	..	1	..	1	14
Electrical Appliances	1	..	2	..	..	..	1	1	..	..	..	..	2	7
Electric Light and Power Plants	..	1	..	..	..	..	..	1	..	..	..	..	..	2
Elevators, Grain	..	4	5	..	2	..	2	1	1	1	2	..	1	19
Excelsior Factories	..	..	2	..	..	..	..	..	1	..	..	..	..	3

Table No. 5 — Continued.

	Water shut off sprinklers.	Generally defective equipment and unsprinklered portions.	Defective water supply or supplies.	Sprinkler system crippled due to freezing.	Slow operation of dry system or defective dry valve.	Slow or defective operation of high test heads.	Faulty building construction, concealed spaces, vertical openings.	Obstruction to distribution.	Hazard of occupancy too severe for average sprinkler equipment.	Sprinkler system crippled by explosion.	Exposure or conflagration.	Plugged Heads.	Miscellaneous.	Total.
Fertilizer Plants	2	1	..	..	1	..	..	..	..	..	..	..	..	4
Flour and Grist Mills	4	2	1	..	1	..	1	1	1	3	2	..	1	17
Forge and Smithy	..	..	..	..	..	..	..	1	..	..	.	..	..	1
Foundries	10	1	1	..	..	..	..	..	..	1	..	..	..	13
Fur Works	..	..	..	..	..	..	1	..	..	..	..	..	..	1
Furniture Factories	24	15	3	3	..	..	3	9	8	1	4	2	1	73
Furniture Stores	4	..	..	..	..	..	1	..	..	..	..	..	..	5
Garages	4	..	..	..	..	..	..	2	..	..	..	..	..	6
Garbage Reduction Plants	1	..	..	..	..	..	..	..	..	..	..	..	..	1
Glass Works	2	2	2	1	..	..	1	1	..	..	..	..	3	12
Glove Factories	1	..	..	..	..	..	..	..	..	..	..	..	..	1
Glue Factories	1	..	..	..	..	..	..	..	1	..	..	..	..	2
Groceries	4	..	1	..	1	..	..	..	..	..	..	..	..	6
Hardware Stores	1	..	..	..	..	..	..	..	..	..	..	..	..	1
Harness and Fancy Leather	..	..	..	..	..	..	..	..	..	..	..	..	1	1
Hat Factory	4	3	1	..	1	..	..	1	..	..	..	..	2	12
Hatters' Fur Mfg	3	..	1	..	..	..	1	..	..	..	..	..	..	5
Hotels	1	..	1	..	..	..	..	..	..	..	..	..	..	2
Institutions	..	..	..	..	1	..	..	..	..	..	..	..	..	1
Jewelry Shops	2	1	..	2	..	..	1	..	..	..	..	..	..	6
Junk Shops	1	..	..	..	..	..	..	..	..	..	..	..	..	1
Knitting, Cop Yarn	1	1	3	..	..	..	..	1	..	1	..	..	..	7
Knitting, Full Process	7	9	5	1	1	..	1	..	..	1	..	..	..	25
Laundries	2	..	..	..	..	..	..	1	..	..	..	..	..	3
Lead Pencil Works	..	..	..	..	..	..	..	..	..	1	..	..	..	1
Linseed Oil Works	1	..	..	..	..	..	..	..	..	2	..	..	1	4
Machine Shops	15	5	1	1	..	1	..	..	..	1	..	..	..	24
Match Factories	2	..	..	..	..	..	..	..	1	..	..	..	1	4
Mattress Factories	5	2	..	1	..	..	..	2	..	..	..	..	..	10
Mercantile (Miscel.)	7	4	1	2	..	..	3	..	..	..	4	..	1	22
Metal Workers†	17	15	2	..	..	2	3	2	4	3	2	2	4	56
Miscellaneous	14	6	2	1	1	1	2	1	7	1	2	..	4	42
Morocco Leather Shops	3	3	..	..	1	..	1	..	..	..	..	..	1	9
Motion Pictures	1	..	..	..	..	..	..	..	..	..	..	..	..	1
Multiple Occupancy	..	..	..	..	..	..	..	..	..	1	..	..	..	1
Munitions Factories	2	..	..	1	..	..	..	..	4	1	..	..	1	9
Musical Instrument Factories	1	3	..	..	..	..	1	..	..	..	1	..	..	6
Oilcloth and Linoleum Works	..	5	..	..	..	..	1	3	12	..	..	..	..	21
Oil Clothing	..	..	..	..	..	..	..	..	..	..	..	..	1	1
Oil Refinery (Vegetable)	..	..	1	..	..	..	..	..	..	..	..	..	..	1
Packing House and Slaughter	1	2	1	..	2	..	..	..	1	..	..	..	1	8
Paint and Varnish Works	1	3	4	..	..	..	3	..	1	..	..	..	..	12
Paper Box and Papeterie	4	1	..	..	1	..	..	..	..	..	..	..	..	6
Paper Mills	14	20	7	3	1	3	2	1	4	2	2	1	11	71
Patent Leather Works	1	..	1	1	..	..	1	..	..	..	..	..	..	4
Phonograph Works	1	..	..	..	..	..	..	..	..	..	..	..	..	1
Photograph Works	1	..	..	..	..	..	..	..	..	..	..	..	..	1

Table No. 5—Concluded.

	Water shut off sprinklers.	Generally defective equipment and unsprinklered portions.	Defective water supply or supplies.	Sprinkler system crippled due to freezing.	Slow operation of dry system or defective dry valve.	Slow or defective operation of high test heads.	Faulty building construction, concealed spaces, vertical openings.	Obstruction to Distribution.	Hazard of occupancy too severe for average sprinkler equipment.	Sprinkler system crippled by explosion.	Exposure or conflagration.	Plugged Heads.	Miscellaneous.	Total.
Picture Frame Factories	1	2	1	1	..	..	..	1	..	..	..	..	..	6
Piers and Wharves	..	1	1	..	..	..	..	..	..	..	..	..	..	2
Potteries	1	1	1	1	..	..	..	..	..	1	..	..	..	5
Printing and Lithographing	7	4	1	..	..	..	1	1	..	..	3	..	1	18
Pulp Mills	8	3	4	..	1	1	1	..	1	1	..	..	1	21
Railroad Property	1	..	..	..	..	..	..	..	..	..	..	..	..	1
Restaurants	..	1	..	..	..	..	1	..	..	..	..	..	..	2
Rice Mills	..	..	1	..	..	..	..	..	..	..	..	..	..	1
Rolling, Wire and Tube Works	..	..	..	..	..	1	1	..	..	..	..	..	..	2
Roofing Works	2	2	..	1	..	..	1	..	..	1	..	..	..	7
Rubber Cloth Mill	..	..	..	..	..	..	..	..	..	..	..	..	1	1
Rubber Reclaiming Works	1	..	..	..	..	..	1	..	1	1	..	..	..	4
Rubber Works	8	..	..	1	..	..	..	1	5	4	..	1	1	21
Saw and Planing Mills	11	10	3	..	4	1	6	2	4	..	5	1	3	50
Ships and Shipbuilding	1	..	..	..	..	..	..	..	..	..	..	..	..	1
Shoddy Mills	6	3	6	..	1	3	..	1	..	..	..	..	1	21
Silk Mills	2	1	..	..	..	..	..	..	..	1	..	..	..	4
Soap Manufacturing	..	1	..	..	..	..	..	..	..	..	..	..	..	1
Stamping and Sheet Metal Works	1	3	1	..	1	..	2	1	..	..	2	..	1	12
Starch and Glucose Mills	..	..	..	..	..	..	..	..	1	7	..	..	..	8
Sugar Refineries	1	..	..	..	..	..	..	..	..	1	..	..	..	2
Tanneries	1	1	..	3	..	..	..	..	1	..	1	..	1	8
Tenant Manufacturing	27	8	2	2	1	..	3	1	1	..	6	..	3	54
Theatres	3	2	..	..	..	..	..	..	..	..	..	..	..	5
Tobacco Factories	1	1	..	..	..	..	..	..	..	..	1	..	..	3
Trunk Factories	2	1	..	..	..	..	..	..	..	..	..	..	..	3
Wall Paper Factories	..	..	1	..	..	..	..	1	1	..	1	..	..	4
Warehouses	12	3	2	..	2	..	1	4	1	..	..	..	4	29
Waste and Batting Mills	5	4	3	1	..	1	..	1	2	..	..	..	1	18
Waste Paper and Rag Shops	3	1	..	..	..	..	..	..	..	..	..	..	..	4
Weaving Mills	1	1	2	1	..	..	..	..	..	..	..	..	..	5
Window Shade Factories	..	..	..	1	..	..	..	..	1	..	..	..	..	2
Woodworkers, Class A*	10	9	2	..	1	1	1	6	..	3	3	1	4	41
Woodworkers, Class B*	6	8	2	2	..	2	1	1	..	3	2	..	2	29
Woodworkers, Class C*	4	4	2	..	..	..	..	2	..	..	..	..	..	12
Woodworkers, Class D*	1	7	..	1	1	..	..	..	..	2	4	..	3	19
Woodworkers, Class E*	4	2	1	..	2	1	2	..	..	..	1	..	..	13
Woodworkers, Class F*	2	..	1	..	..	..	..	1	..	..	..	..	..	4
Woolen Mills	16	18	13	1	..	2	4	..	1	..	3	..	8	66
Wool Storehouses	..	2	..	..	..	..	..	..	..	..	..	..	..	2
Worsted Mills	3	3	2	1	..	..	1	..	..	..	..	..	4	14
Total Unsatisfactory Fires	441	289	130	42	38	25	73	83	86	64	72	11	107	1461

*See detailed classification of Woodworkers as given in note under Table No. 4.

†See note on Metal Workers under Table No. 4.

VOLUME XIX. INDEX.

	Quarterly No.	Page No.
A		
Adventures in Standardization (*H. B. Clark*)	3	239
Allentown, Pa., Hotel Fire (*E. S. Chapin*)	4	364
Aluminum Dust Fires, Extinguishing	1	53
Annual Summary of Fires in Sprinklered Properties	4	396
Apartment Fire, Detroit, Gladsonia (*Michigan Inspection Bureau*)	2	187
B		
Baltimore, Lyceum Theatre Fire (*C. V. Gordon*)	1	93
Bridge Fire, St. Paul (*John Townsend, Jr.*)	1	96
Buffalo Fire, Four-Alarm (*New York Fire Insurance Rating Organization*)	1	82
Bureau of Standards' Fire Test Activities	3	234
C		
Calamity (*Ruth Dinwiddie*)	2	114
Captain Conway, Fire Preventionist (*Ralph Richman*)	2	138
Chateau Frontenac Fire, The	4	369
Chicago, Private Fire Service Charges in	4	344
Chimneys and Flues, Stopping Fires Due to (*D. Knickerbacker Boyd*)	4	323
Cities' Legal Power to Prevent Fires	4	349
City Inspections (*Eugene Arms*)	3	237
Coal Piles, Preventing Fires in (*Associated Factory Mutual Fire Insurance Companies*)	2	140
Conflagration, Nahant, Mass.	1	86
Conflagration, Shreveport (*Louisiana Fire Prevention Bureau*)	2	175
Co-operating for Effective Work (Editorial from *The National Underwriter*)	1	9
Council Bluffs Conflagration (*Iowa Insurance Service Bureau*)	3	258
Crepe Rubber Soles (*Wm. G. Hayne*)	1	72
Crossed Wires (Photograph)	2	148
D		
Detroit, Gladsonia Apartment Fire (*Michigan Inspection Bureau*)	2	187
Dry Cleaning Tragedy, A Home	4	322
Dynamite in Fire Fighting (*H. E. Davis*)	1	29
E		
Editorials: No. 1, page 5; No. 2, page 105; No. 3, page 205	4	309
Electrical Reinspection in New York City (*J. C. Forsyth*)	2	145
Electric Transformers, Hazards of	1	74
Equitable Building Fire, The Second (*William B. White*)	4	373
Executive Committee Action	2	112
Executive Committee Meetings, No. 1, page 13,	4	315
Explosion, Laclede Gas Company Building (*St. Louis Fire Prevention Bureau*)	3	278
Extinguishers, Nurses Taught to Use	1	19
F		
Factory Building, Outside Sprinklers Save	4	367
Film Booth Fire, A	4	328
Film Exchange Fire Prevention Results	3	224
Film Fancy, A New (New Orleans *Times-Picayune*)	2	129
Film Fire Panic, Mexico City (*Clarence Heller*)	2	172
Fire Department, The Youngest (*G. L. Knotts*)	1	51
Fire Extinguishers, On	3	220
Fire Extinguishers, State Legislation on (*D. S. Hunter*)	3	255
Fire from Overloaded Service Wires (Photograph)	2	144
Fire Hazard of Refrigerants (*A. H. Nuckolls*)	2	168
Fire Hazards, Pipe Covering	3	265

	Quarterly No.	Page No.
Fire Loss Statistics, 1924—No. 1, page 20; 1925—	3	229
Fire Prevention from a Manufacturer's Viewpoint (*H. L. Miner*)	2	116
Fire Prevention, Fun Learning	2	122
Fire Prevention in Japan	3	274
Fire Prevention Legislation (*Geo. W. Booth*)	3	232
Fire Prevention, Museum (*Edward R. Hardy*)	1	55
Fire Preventionist, Captain Conway (*Ralph Richman*)	2	138
Fire Record—Gas Plants	3	284
Fire Record—Leather Working	2	194
Fire Record—Welding Processes	1	88
Fires, Loss of Life: No. 1, 97; No. 2, 198; No. 3, 302;	4	393
Fire Test Activities, Bureau of Standards'	3	234
Floor Coverings, Plastic	3	293
Foundation Is Ready, The (Editorial in *Fire Protection*)	1	12
Fourth of July Toll, The	2	142
Frame Buildings, Fires in (Concerning Statistics Circulated by Nation-Lumber Manufacturers' Association)	3	216
Fudged Figures	3	216
G		
Galveston Wharf Fire—Mallory Line Piers (*H. Oram Smith*)	4	383
Gas Plants—Fire Record	3	284
Gladsonia Apartment Fire, Detroit (*Michigan Inspection Bureau*)	2	187
Glasgow, Kelvin Hall Fire (*Alexander Young*)	2	180
H		
Hose Couplings, Standardization in New England (*H. B. Clark*)	3	239
Hotel Fire, Allentown, Pa., Lafayette (*E. S. Chapin*)	4	364
I		
Individual Liability Upheld	3	267
J		
Japan, Fire Prevention in	3	274
K		
Kansas City Theatre Disaster (Frontispiece)	1	4
Kelvin Hall Fire, Glasgow (*Alexander Young*)	2	180
L		
Laclede Gas Company Building Explosion (*St. Louis Fire Prevention Bureau*)	3	278
Lafayette Hotel Fire, Allentown, Pa. (*E. S. Chapin*)	4	364
Leather Working—Fire Record	2	194
Legal Power of Cities to Prevent Fires	4	349
Legislation, Fire Prevention (*Geo. W. Booth*)	3	232
Legislation on Fire Extinguishers, State (*D. S. Hunter*)	3	255
Liability for Preventable Fire, Court Decisions on: No. 2, 137; No. 3, 267	4	347
Lightning Fire in Manila, P. I., A (*E. E. Elser*)	2	192
Low Temperature Ignition of Wood	2	159
M		
Madison, Wisconsin, Theatre Fire	3	261
Manila, P. I., A Lightning Fire in (*E. E. Elser*)	2	192
Manizales Conflagration (Frontispiece)	2	104
Manufacturer's Viewpoint, Fire Prevention from a (*H. L. Miner*)	2	116
Mexico City Film Fire Panic (*Clarence Heller*)	2	172
Museum Fire Prevention (*Edward R. Hardy*)	1	55
N		
Nahant, Mass., Conflagration	1	86
New Orleans Wharf Fire (*Walter K. Grant*)	3	247
New York Pier Fire (*New York Board of Fire Underwriters*)	2	189
Nitro-Cellulose Process Fire, A, (*Underwriters' Bureau of New England*)	3	289
Nurses Taught to Use Extinguishers	1	19

	Quarterly No.	Page No.
O		
Oil Burners, Anti-Syphoning Piping for (*B. K. Breed*)	1	78
Oil Burners, Care of Domestic (*E. J. Smith*)	2	132
Oil Burning Torches (*R. O. Matson*)	2	135
Oil Refining Co. Fire, Utah (*A. J. Snow*)	3	297
Oil Tanks, Steam Protection for (*G. O. Wilson*)	4	330
Outside Sprinklers Save Factory Building	4	367
P		
Personal Liability Decision, Another	4	347
Pictorial Comment, (*Cartoons*) No. 1, 10; No. 2, 110; No. 3, 214;	4	320
Pier Fire, New York (*New York Board of Fire Underwriters*)	2	189
Pipe Covering Fire Hazards	3	265
Planning a Local Campaign for Fire Prevention (Cartoon)	4	314
Plastic Floor Coverings	3	293
Poker as Priest, The (*G. K. Chesterton*)	4	329
Private Fire Service Charges in Chicago	4	344
Private Residences, Specifications for—Amendments	2	112
Pyroxylin Lacquer Spray Fire, A (*Western Factory Insurance Association*)	4	388
R		
Rayon, Silk and (*Wm. D. Grier*)	4	352
Record Protection, A Credit Asset (*W. W. Orr*)	2	123
Refrigerants, Fire Hazard of (*A. H. Nuckolls*)	2	168
Road Fires (*Engineering News-Record*)	3	213
Rubber Soles, Crepe (*Wm. G. Hayne*)	1	72
Rubbish Burning Hazard, A (Photograph)	1	62
S		
St. Paul Bridge Fire (*John Townsend, Jr.*)	1	96
Salvage Inspections (*Frank C. McAuliffe*)	3	253
San Francisco Chamber of Commerce Fire (*A. D. Lange*)	2	131
Shreveport Conflagration (*Louisiana Fire Prevention Bureau*)	2	175
Silk and Rayon (*Wm. D. Grier*)	4	352
Sprinklered Properties, Annual Summary of Fires in	4	396
Standardization of Hose Couplings, Adventures in (*H. B. Clark*)	3	239
Standpipe System Pressure Regulation By Means of Restriction Orifices (*A. W. Claussen*)	3	275
State Legislation on Fire Extinguishers (*D. S. Hunter*)	3	255
Steam Protection for Oil Tanks (*G. O. Wilson*)	4	330
S. S. Lenape Fire (*A. J. Smith*)	3	263
T		
Theatre Fire, Baltimore Lyceum (*C. V. Gordon*)	1	93
Theatre Fire, Madison, Wisconsin	3	261
Torches, Oil Burning (*R. O. Matson*)	2	135
U		
Uninsulated Steel Vault Doors (*R. K. Porter*)	1	39
Utah Oil Refining Co. Fire (*A. J. Snow*)	3	297
V		
Vault Doors, Uninsulated Steel (*R. K. Porter*)	1	39
W		
Water Distribution Systems, Small Town (*Clarence Goldsmith*)	2	149
Welding Processes—Fire Record	1	88
Wharf Fire, Galveston—Mallory Line Piers (*H. Oram Smith*)	4	383
Wharf Fire, New Orleans (*Walter K. Grant*)	3	247
Wood, Low Temperature Ignition of	2	159
Woodworkers; Their Hazards (*Edmond F. Sisson*)	1	63
Z		
Zoning, Height Limitations in (*Jacob L. Crane, Jr.*)	1	23